

4.2.4.2.6 Air Quality

The basic implementation of Management Alternative 1 would only result in minor impacts on air quality at any of the potential foreign research reactor spent nuclear fuel management sites. The projected emissions from foreign research reactor spent nuclear fuel storage at the potential management sites would not contribute to Federal or State nonattainment standards. Construction activities would be expected to cause only temporary, minor increases in fugitive dust emissions, but the use of standard dust suppression techniques would be expected to mitigate this problem. Particulate emissions could temporarily affect visibility in localized areas, but would not adversely affect Federal or State attainment standards.

4.2.4.2.7 Water Quality

The basic implementation of Management Alternative 1 would have only minor impacts on water resources at the potential foreign research reactor spent nuclear fuel management sites. Water consumption during construction would require very small amounts of water when compared to daily water usage at the potential management sites.

During operations, the greatest amount of water consumed annually would be about 2.1 million liters (550,000 gal) per year. This amount represents no more than 0.2 percent of the annual water consumption at any of the potential foreign research reactor spent nuclear fuel management sites. At the Nevada Test Site, where available water is limited, a cumulative water supply impact could be important from activities other than foreign research reactor spent nuclear fuel management, but the foreign research reactor spent nuclear fuel management contribution would be very small. Further study of the Ash Meadows sub-basin would be required to specify the exact impact on aquifer yield and integrity.

Under normal operations there would be no direct discharge of effluent to ground or surface waters from a new dry storage facility.

4.2.4.2.8 Ecology

The basic implementation of Management Alternative 1 would only result in minor ecological impacts at the potential foreign research reactor spent nuclear fuel management sites. Under any construction of new facilities, individual or small populations of some wildlife species could be disturbed, displaced, or destroyed. However, the size of the areas affected would be small in relation to the size of the potential foreign research reactor spent nuclear fuel management sites and the size of remaining natural habitats. The type of habitats affected could vary but would be typical of the regional area in which the foreign research reactor spent nuclear fuel storage facility is located. For this reason, any such habitat losses would probably not affect any threatened or endangered species or critical habitats in the area. Habitat fragmentation is not expected because new storage facilities would be constructed on land that has been previously disturbed or designated for industrial purposes. Mitigation plans would be developed in consultation with the appropriate agencies if any threatened or endangered species were identified.

DOE has begun or has completed consultations with the U.S. Fish and Wildlife Service regarding threatened and endangered species for the proposed construction site of foreign research reactor spent nuclear fuel storage facilities at the five potential sites, as required by the Endangered Species Act.

4.2.4.2.9 Noise

The basic implementation of Management Alternative 1 would only result in minor noise impacts at the potential foreign research reactor spent nuclear fuel management sites. Construction activities would generate noise levels consistent with light industrial activity. Based on existing studies these noises would not be expected to propagate offsite at levels that would affect the general population. Noises generated during operations would be less than those during construction.

4.2.4.2.10 Materials, Utilities, and Energy

The basic implementation of Management Alternative 1 would only result in minor impacts on materials, utilities, and energy at the potential foreign research reactor spent nuclear fuel management sites. For existing facilities, incremental increases in materials, utilities, and energy would be very small. New dry storage facilities would result in increased demands on water, power, and sewage. The increased water usage during construction would add no more than 0.2 percent to existing sitewide levels. Increased annual electricity requirements would be about 800 to 1,000 megawatt hours per year and the increased sewage generation would be no more than 1.59 million liters per year (420,000 gal per year), which is less than one percent above existing sitewide levels. At the Nevada Test Site, a central sewage treatment system would have to be constructed for spent nuclear fuel management activities, which would include the foreign research reactor spent nuclear fuel storage facilities. However, all other existing system capacities could manage the estimated increases for materials, utilities, and energy.

4.2.4.2.11 Waste Management

The basic implementation of Management Alternative 1 would only result in minor waste management impacts at the potential foreign research reactor spent nuclear fuel management sites. At all potential management sites the amount of waste generated from foreign research reactor spent nuclear fuel storage is very small when compared to the annual waste projection for each site.

4.2.4.3 Key Cumulative Impacts at the Potential Foreign Research Reactor Spent Nuclear Fuel Management Sites

All of the potential foreign research reactor spent nuclear fuel management sites contain facilities unrelated to foreign research reactor spent nuclear fuel that may continue to operate throughout the foreign research reactor spent nuclear fuel program (approximately 40 years). Impacts from both construction and operation of foreign research reactor spent nuclear fuel facilities would be cumulative with the impacts of existing and planned facilities or actions such as environmental restoration and waste management activities unrelated to foreign research reactor spent nuclear fuel and impacts from the management of DOE's spent nuclear fuel inventory.

This section compares the impacts of the basic implementation of Management Alternative 1 and of the implementation alternatives presented in Section 4.3 to the cumulative impacts at each site. The site-specific cumulative impacts are discussed in more detail in Appendix F.

4.2.4.3.1 Key Cumulative Impacts at the Savannah River Site

Table 4-29 presents the key cumulative impacts from ongoing actions and reasonably foreseeable actions at the Savannah River Site, including:

Table 4-29 Key Cumulative Impacts at the Savannah River Site

| <i>Environmental Impact Parameter</i> | <i>FRR SNF Receipt and Storage Contribution</i> | <i>FRR SNF Receipt and Chemical Separation Contribution</i> | <i>Current Activities^a</i> | <i>Other Activities^b</i> | <i>Cumulative Impact</i> |
|---|---|---|---------------------------------------|-------------------------------------|--------------------------|
| <i>Occupational and Public Health and Safety:</i> | | | | | |
| • MEI Dose (mrem/yr) | 0.00036 | 0.66 | 0.25 | 4.1 | 5.0 |
| LCF (per year) | 1.8×10^{-10} | 3.3×10^{-7} | 1.25×10^{-7} | 0.000002 | 0.0000025 |
| • Population Dose (person-rem/yr) | 0.022 | 27 | 9.1 | 295 | 331 |
| LCF (per year) | 0.000011 | 0.014 | 0.0045 | 0.15 | 0.17 |
| • Worker Collective Dose (person-rem/yr) | 10 ^c | 21 | 263 | 1,418 | 1700 |
| LCF (per year) | 0.004 | 0.0084 | 0.10 | 0.57 | 0.68 |
| <i>Waste Generation:</i> | | | | | |
| • High-Level (canisters/yr) | 0 | 6.5 | (d) | 190 ^e | 190 ^e |
| • Saltstone (m ³ /yr) | 0 | 370 | (d) | 60,000 | 60,000 |
| • Transuranic (m ³ /yr) | 0 | 0 | (d) | 1,038 | 1,038 |
| • Mixed/Hazardous (m ³ /yr) | 0 | 8 | (d) | 2,561 | 2,569 |
| • Low-Level (m ³ /yr) | 22 | 5,700 | (d) | 35,600 | 41,300 |

FRR SNF = Foreign Research Reactor Spent Nuclear Fuel

^a Based on 1993 site data

^b Other activities include: interim management of nuclear materials, spent nuclear fuel management, Vogtle plant operation, defense waste processing facility, stabilization of plutonium-solutions, site-wide waste management activities, tritium accelerator facility, disposition of surplus HEU, storage and disposition of weapons-usable fissile materials, and the stockpile stewardship and management program activities.

^c The dose is due to the handling of the FRR SNF during receipt and transfer between facility, averaged over 40 years.

^d Included in "other activities"

^e Expected Defense Waste Processing Facility canister production rate (DOE, 1995b).

- The operation of the Vogtle Electric Generating Plant located approximately 16 km (10 mi) south west of the center of the Savannah River Site.
- The implementation of the preferred alternative in the Management of Nuclear Materials EIS.
- Shipment of aluminum-based spent nuclear fuel to the Savannah River Site for storage and disposal discussed in Appendix C of the Programmatic SNF & INEL Final EIS.
- Completion of the construction and operation of the Defense Waste Processing Facility.
- Processing of F-Canyon plutonium solutions to metal.
- Treatment and minimization of radioactive and hazardous wastes at the site as identified in the Savannah River Site Waste Management Final EIS.
- Construction of an accelerator for tritium production at the Savannah River Site, along with associated support facilities.
- Disposition of Surplus Highly Enriched Uranium at the site.
- Storage and Disposition of Weapons-Usable Fissile Materials.

- Stockpile Stewardship and Management Program.
- Current Savannah River Site projects (based on 1993 data).

Table 4-29 also shows the impacts of receipt and near-term chemical separation at the Savannah River Site, from Implementation Alternative 6 of Management Alternative 1 in Section 4.3.6. These impacts are sufficiently distinct from those of the other alternatives that they are presented separately. These impacts would occur only while the chemical separation facilities are operating.

The results in Table 4-29 show that the contribution of foreign research reactor spent nuclear fuel to the cumulative impacts at the Savannah River Site would be minimal.

4.2.4.3.2 Key Cumulative Impacts at the Idaho National Engineering Laboratory

Table 4-30 presents the key cumulative impacts from ongoing actions and reasonably foreseeable actions at the Idaho National Engineering Laboratory, including the proposed construction and operation of an accelerator facility for tritium production (along with associated support facilities), the management of DOE-owned spent nuclear fuel discussed in Appendix B of the Programmatic SNF&INEL Final EIS, and the storage and disposition of weapons-usable fissile materials at the Idaho National Engineering Laboratory site.

Table 4-30 Key Cumulative Impacts at the Idaho National Engineering Laboratory

| <i>Environmental Impact Parameter</i> | <i>FRR SNF Receipt and Storage Contribution</i> | <i>FRR SNF Receipt and Chemical Separation Contribution</i> | <i>Current Activities^a</i> | <i>Other Activities^a</i> | <i>Cumulative Impact</i> |
|---|---|---|---------------------------------------|-------------------------------------|--------------------------|
| <i>Occupational and Public Health and Safety:</i> | | | | | |
| • MEI Dose (mrem/yr) | 0.00056 | 0.048 | 0.056 | 0.0057 | 0.11 |
| LCF (per year) | 2.8×10^{-10} | 2.4×10^{-8} | 2.8×10^{-8} | 2.8×10^{-9} | 5.5×10^{-8} |
| • Population Dose (person-rem/yr) | 0.0045 | 0.39 | 0.34 | 32 | 33 |
| LCF (per year) | 2.3×10^{-6} | 0.00020 | 0.00017 | 0.016 | 0.016 |
| • Worker Collective Dose (person-rem/yr) | 10^b | 18 | 30 | 344 | 392 |
| LCF (per year) | 0.004 | 0.0072 | 0.012 | 0.137 | 0.16 |
| <i>Waste Generation:</i> | | | | | |
| • High-Level (canisters/yr) | 0 | 7.5 | 0 | 327 ^c | 327 ^c |
| • Grout (m ³ /yr) | 0 | 167 | 0 | 875 ^d | 875 ^d |
| • Transuranic (m ³ /yr) | 0 | 0 | 712 | 46 | 758 |
| • Mixed/Hazardous (m ³ /yr) | 0 | 8 | 243 | 8 | 259 |
| • Low-Level (m ³ /yr) | 22 | 5,700 | 4,795 | 2,800 | 13,300 |

FRR SNF = Foreign Research Reactor Spent Nuclear Fuel

^a Other activities include: DOE-owned spent nuclear fuel management, construction and operation of a tritium accelerator facility, and the disposition of weapons-usable fissile materials.

^b The dose is due to the handling of FRR SNF during receipt and transfer, averaged over 40 years.

^c Assumed canister production rate (DOE, 1995b).

^d Design capacity of the proposed Waste Immobilization Facility, which is not funded.

Table 4-30 also shows the impacts of receipt and near-term chemical separation at the Idaho National Engineering Laboratory, from Implementation Alternative 6 of Management Alternative 1 in Section 4.3.6. These impacts are sufficiently distinct from those of the other alternatives that they are presented separately. These impacts would occur only while the chemical separation facilities are operating.

The results in Table 4-30 show that the contribution of foreign research reactor spent nuclear fuel management to the cumulative impacts at the Idaho National Engineering Laboratory would be minimal.

4.2.4.3.3 Key Cumulative Impacts at the Hanford Site

Table 4-31 presents the key cumulative impacts from ongoing actions and reasonably foreseeable actions at the Hanford Site, including those discussed in the Programmatic SNF&INEL Final EIS, the Management of Spent Nuclear Fuel from the K Basins Draft EIS, and the Safe Interim Storage of Hanford Tank Wastes Final EIS.

Table 4-31 Key Cumulative Impacts at the Hanford Site

| <i>Environmental Impact Parameter</i> | <i>FRR SNF Contribution</i> | <i>Other Activities^a</i> | <i>Cumulative Impact</i> |
|---|-----------------------------|-------------------------------------|--------------------------|
| <i>Occupational and Public Health and Safety:</i> | | | |
| • MEI Dose (mrem/yr) | 0.00025 | 0.0036 | 0.0036 |
| LCF (per year) | 1.3×10^{-10} | 1.5×10^{-9} | 1.5×10^{-9} |
| • Population Dose (person-rem/yr) | 0.015 | 0.22 | 0.235 |
| LCF (per year) | 0.0000075 | 0.00011 | 0.00011 |
| • Worker Collective Dose (person-rem/yr) | 8.9 ^b | 116.5 | 125.4 |
| LCF (per year) | 0.0035 | 0.0466 | 0.05 |
| <i>Waste Generation:</i> | | | |
| • High-Level (canisters/yr) | 0 | 320 ^c | 320 ^c |
| • Transuranic (m ³ /yr) | 0 | 240 | 240 |
| • Mixed/Hazardous (m ³ /yr) | 0 | 402 | 402 |
| • Low-Level (m ³ /yr) | 22 | 33,310 | 33,332 |

FRR SNF = Foreign Research Reactor Spent Nuclear Fuel

^a *Other activities include: DOE-owned spent nuclear fuel management, construction and operation of a Laser Interferometer Gravitational-Wave Observatory, decommissioning of unused facilities, site restoration activities, interim storage and tank wastes, management of spent nuclear fuel from the K basins, and current activities.*

^b *The dose is due to the handling of FRR SNF during receipt, averaged over 30 years.*

^c *Assumed canister production rate (DOE, 1995b).*

The results in Table 4-31 show that the contribution from management of foreign research reactor spent nuclear fuel to the cumulative impacts at the Hanford Site would be minimal.

4.2.4.3.4 Key Cumulative Impacts at the Oak Ridge Reservation

Table 4-32 presents the key cumulative impacts from ongoing actions and reasonably foreseeable actions at the Oak Ridge Reservation, including those discussed in the programmatic SNF&INEL Final EIS, the Tritium Supply and Recycling Final EIS, and the Disposition of Surplus Highly Enriched Uranium Draft EIS. Other activities considered for the Oak Ridge Reservation which could affect the site environment have not been determined sufficiently at this time to allow impact evaluation. They include activities associated with the waste management at the site, storage and disposition of weapons-usable fissile materials, and stockpile stewardship and management program.

Table 4-32 Key Cumulative Impacts at the Oak Ridge Reservation

| <i>Environmental Impact Parameter</i> | <i>FRR SNF Contribution</i> | <i>Other Activities^a</i> | <i>Cumulative Impact</i> |
|---|-----------------------------|-------------------------------------|--------------------------|
| <i>Occupational and Public Health and Safety:</i> | | | |
| • MEI Dose (mrem/yr) | 0.09 | 15.5 | 15.6 |
| LCF (per year) | 4.5×10^{-8} | 0.0000077 | 0.0000078 |
| • Population Dose (person-rem/yr) | 0.085 | 94.5 | 94.6 |
| LCF (per year) | 0.000043 | 0.047 | 0.047 |
| • Worker Collective Dose (person-rem/yr) | 8.9 ^b | 261.3 | 270.2 |
| LCF (per year) | 0.0036 | 0.104 | 0.108 |
| <i>Waste Generation:</i> | | | |
| • High-Level (canisters/yr) | 0 | 0 | 0 |
| • Transuranic (m ³ /yr) | 0 | 16 | 16 |
| • Mixed/Hazardous (m ³ /yr) | 0 | 119,411 | 119,411 |
| • Low-Level (m ³ /yr) | 22 | 34,989 | 35,011 |

FRR SNF = Foreign Research Reactor Spent Nuclear Fuel

^a Other activities include: DOE-owned spent nuclear fuel management, construction and operation of the Expended Core Facility, the construction and operation of the Advanced Neutron Source Facility, construction and operation of a Tritium production facility, and surplus highly-enriched uranium management activities at the site.

^b The dose is due to the handling of FRR SNF during receipt, averaged over 30 years.

The results in Table 4-32 show that the contribution from storage of foreign research reactor spent nuclear fuel to the cumulative impacts at the Oak Ridge Reservation would be minimal.

4.2.4.3.5 Key Cumulative Impacts at the Nevada Test Site

Table 4-33 presents the key cumulative impacts from ongoing actions and reasonably foreseeable actions at the Nevada Test Site, including those discussed in the Programmatic SNF&INEL Final EIS and the Tritium Supply and Recycling Final EIS. The Programmatic SNF&INEL Final EIS includes the quantitative impacts from a proposed Expended Core Facility at the Site. The Nevada Test Site is also considered in the storage and disposition of weapons-usable fissile materials program which could affect the site environment. The impacts from this program have not been determined sufficiently at this time to allow impact evaluation.

The results in Table 4-33 show that the contribution from storage of foreign research reactor spent nuclear fuel to the cumulative impacts at the Nevada Test Site would be minimal.

4.2.4.4 Waste Minimization and Mitigation Measures at the Potential Foreign Research Reactor Spent Nuclear Fuel Management Sites

Although environmental impacts at the potential foreign research reactor spent nuclear fuel management sites would be minimal in all environmental media and mitigation measures would not be necessary, the sites would implement measures in some areas to minimize impacts. Mitigation measures would be taken in the areas of pollution control, socioeconomics, cultural resources, air and water resources, occupational and public health and safety, and accident prevention. Appendix F provides details on these issues.

Table 4-33 Key Cumulative Impacts at the Nevada Test Site

| <i>Environmental Impact Parameter</i> | <i>FRR SNF Contribution</i> | <i>Other Activities^a</i> | <i>Cumulative Impact</i> |
|---|-----------------------------|-------------------------------------|--------------------------|
| <i>Occupational and Public Health and Safety:</i> | | | |
| • MEI Dose (mrem/yr) | 0.00076 | 0.31 | 0.31 |
| LCF (per year) | 3.8×10^{-10} | 1.55×10^{-7} | 1.55×10^{-7} |
| • Population Dose (person-rem/yr) | 0.00093 | 0.095 | 0.095 |
| LCF (per year) | 4.7×10^{-7} | 0.00047 | 0.00047 |
| • Worker Collective Dose (person-rem/yr) | 8.9 ^b | 81 | 89.9 |
| LCF (per year) | 0.0036 | 0.032 | 0.035 |
| <i>Waste Generation:</i> | | | |
| • High-Level (canisters/yr) | 0 | 0 | 0 |
| • Transuranic (m ³ /yr) | 0 | 16 | 16 |
| • Mixed/Hazardous (m ³ /yr) | 0 | 252 | 252 |
| • Low-Level (m ³ /yr) | 22 | 44,578 | 44,600 |

FRR SNF = Foreign Research Reactor Spent Nuclear Fuel

^a Other activities include existing activities, DOE-owned spent fuel management activities, construction and operation of an Expanded Core Facility, and construction and operation of a tritium production facility.

^b The dose is due to the handling of foreign research reactor spent nuclear fuel during receipt, averaged over 30 years.

4.2.4.5 Environmental Justice at the Potential Foreign Research Reactor Spent Nuclear Fuel Management Sites

Under incident-free foreign research reactor spent nuclear fuel management site activities associated with receipt and storage of the spent nuclear fuel, the dominant radiological impacts would be the exposures received by the site workers in the immediate vicinity of the spent nuclear fuel container. These individuals are principally those working within the spent nuclear fuel storage facility. As discussed in Section 4.2.4.1, under incident-free operating conditions, no radiological fatalities would be expected among radiation workers or the general public.

Section 4.2.4.1 also discusses radiological effects due to accidents for both wet storage and dry storage. As shown in Tables 4-24 through 4-28, the dominant radiological risks due to accidents are estimated to occur during breach of a spent nuclear fuel assembly. No LCF are expected to result from the basic implementation of Management Alternative 1.

Appendix A describes minority populations and low-income households residing near candidate management sites. Table 4-34 summarizes this description. Calculations for incident-free and accident conditions demonstrate that for the general population the impacts would be very low. Minority or low-income populations living near the potential management sites would not be subjected to any greater impacts. Therefore, these populations would not receive disproportionately high and adverse impacts. They would be subject to very low impacts, as would the general population.

Table 4-34 Summary Description of Minority Populations and Low-Income Households Residing Within 80 km (50 mi) of Candidate Management Sites

| <i>Candidate Management Site</i> | <i>Total Population</i> | <i>Minority Population</i> | <i>Total Households</i> | <i>Low-Income Households</i> |
|---------------------------------------|-------------------------|----------------------------|-------------------------|------------------------------|
| Savannah River Site | 566,823 | 214,016 | 197,937 | 82,930 |
| Idaho National Engineering Laboratory | 176,311 | 15,449 | 55,109 | 22,452 |
| Hanford Site | 383,934 | 95,042 | 136,496 | 57,667 |
| Oak Ridge Reservation | 863,758 | 53,185 | 335,589 | 147,537 |
| Nevada Test Site | 12,421 | 2,005 | 4,194 | 2,024 |

Characterization of the number and location of minority and low-income populations is dependent on how these populations are defined and what assumptions are used in conducting the analysis. As discussed in Appendix A, at the time this Final EIS and the Programmatic SNF&INEL Final EIS were prepared, the Federal Interagency Working Group on Environmental Justice had not issued final guidance on the definitions of minority and low-income populations, or the approach to be used in analyzing environmental justice, as directed by the Executive Order. Final internal DOE guidance on environmental justice has also not been adopted. As a result, both the definitions and assumptions used by and within agencies for conducting environmental justice analyses can vary, and the resulting demographic results can differ on a case-by-case basis. For example, this Final EIS and the Programmatic SNF&INEL Final EIS present demographic characterizations derived from the same United States Census Bureau data base, but these documents used different definitions and assumptions. Several of the same candidate interim spent nuclear fuel management sites were evaluated in both documents. As discussed in Appendix A, variations in these definitions and assumptions led to differences in the characterization of minority and low-income populations surrounding these potential spent nuclear fuel management sites. Nevertheless, although the characterizations differ, the radiological impacts resulting from the proposed action under all alternatives present very low risk to the population as a whole. Therefore, no disproportionately high and adverse effects would be expected for any particular segment of the population, including minority and low-income populations, regardless of which set of definitions and assumptions were applied.

Implementation of the proposed action would have extremely low nonradiological effects on the environment at interim management sites, including the social and economic status of the general population, minority populations, and the low-income population surrounding interim management sites. Economic benefits that would result from increased cargo handling, transportation, and storage at interim management sites would be extremely small for the general population or any particular segment of the population residing near interim management sites.

4.2.4.6 Mitigation Measures at the Potential Foreign Research Reactor Spent Nuclear Fuel Management Sites

Based on the analyses of the environmental consequences for each potential foreign research reactor spent nuclear fuel management site included in Section F.4 of Appendix F, no mitigation measures would be necessary since all potential environmental impacts are substantially below acceptable levels or promulgated standards. However, each potential site would follow operation practices that would minimize the impacts in such areas as pollution prevention, cultural and ecological resources, ground and surface water quality, air quality, noise, traffic, operational and public health and safety, and accident prevention and mitigation. Descriptions of these practices are included in Appendix F, under Mitigation Measures for each site.

4.2.5 Short-Term Uses and Long-Term Productivity

Short-term impacts would be those associated with construction and operation of the storage facilities. No land would be used for the marine or ground transportation of foreign research reactor spent nuclear fuel. The use of land at the potential foreign research reactor spent nuclear fuel management sites would be in conformity with the land use policy of each site. The construction of new storage facility would lead to the loss of small acreage of terrestrial habitat. After adoption of an overall strategy for interim storage of all DOE-owned spent nuclear fuel (including spent fuel from foreign research reactors), some of the areas currently used for interim storage of spent nuclear fuel may be released for other productive uses

(DOE, 1995c). Ecological resources would be directly affected at the area of construction by land clearing. These resources would be limited to small mammals, reptiles, and songbirds. Given the small area that would be used, the overall effect would be of limited impacts on local populations and resources.

4.2.6 Irreversible and Irretrievable Commitments of Resources

The only irreversible use of resources during the marine and ground transportation of foreign research reactor spent nuclear fuel would be the use of petroleum fuel. Irreversible and irretrievable commitment to resources associated with management site activities are discussed below.

4.2.6.1 Management Site Resources

The irreversible and irretrievable commitment of resources resulting from the construction and operation of foreign research reactor spent nuclear fuel management site facilities would involve materials that could not be recovered or recycled, or resources that would be consumed or reduced to unrecoverable forms, including electrical energy, fuel, construction materials, and miscellaneous chemicals. Some construction materials are recyclable. Some of the resources would be irretrievable because of the nature of the commitment or the cost of reclamation. For example, human resources used for the construction and operation of the potential foreign research reactor spent nuclear fuel storage facilities would be irretrievably lost since these resources would be unavailable for use in other work activity areas. On the whole, foreign research reactor spent nuclear fuel management would not be particularly resource-intensive. The quantities of irreversible and irretrievable resources for each site are included in Appendix F, Section F.4.

4.2.6.2 Energy Resources

Under the basic implementation of Management Alternative 1, about 4.6 metric tons (5.1 tons) of highly-enriched uranium would be accepted into the United States. The energy content of this uranium would be equal to about 1.5 million megawatt-days or over 20 million barrels of No. 2 fuel oil if the conversion efficiency were 100 percent.

4.2.7 Impacts of Ultimate Disposition

Ultimate disposition of DOE's spent nuclear fuel, including foreign research reactor spent nuclear fuel, is a high priority. For planning purposes, DOE has determined that its spent nuclear fuel that is not otherwise managed (e.g., chemically separated, with the high-level waste being converted into a vitrified glass for repository disposal) is authorized for disposal in a geologic repository. Decisions regarding the actual disposition of DOE's spent nuclear fuel will follow appropriate review under the National Environmental Policy Act (NEPA).

It is possible that the foreign research reactor spent nuclear fuel could be accepted intact in a geologic repository. If DOE determines that geologic disposal of intact foreign research reactor spent nuclear fuel is possible, then there would be no onsite impacts beyond those associated with storage and packaging of the foreign research reactor spent nuclear fuel.

It is also possible that some form of processing could be necessary to convert the foreign research reactor spent nuclear fuel into a more stable form prior to its ultimate disposal. This processing could be a near-term new treatment technology, conventional chemical separation, or a new treatment technology that is implemented after an interim period of storage. DOE expects that any new treatment technology would produce no greater impacts than historical chemical separation activities. Therefore, the impacts of

near-term treatment of the foreign research reactor spent nuclear fuel would be expected to be no greater than the impacts of chemically separating the same material as discussed in Section 4.3.6. If a new treatment technology is implemented after an interim period of storage and technology development, DOE expects that it would provide a substantial improvement over conventional chemical separation.

When disposal space is available, DOE would transport the intact or processed foreign research reactor spent nuclear fuel to a repository. This transportation would produce impacts similar to the ground transportation impacts discussed in Section 4.4.2.3. Handling and emplacement in the repository would produce impacts similar to those due to handling the spent nuclear fuel or processed waste at the DOE site because similar equipment and procedures would be used and the same regulatory limits on radiation doses would apply.

Yucca Mountain is the candidate site for a geologic repository for both spent nuclear fuel and high-level waste. Under the Nuclear Waste Policy Act, Congress found that a national problem had been created by the accumulation of spent nuclear fuel from commercial reactors and the accumulation of high-level waste. The Nuclear Waste Policy Act assigned to DOE the responsibility for managing the disposal of this spent nuclear fuel and high-level waste, specified the siting process, and authorized the construction of one geologic repository. Under the Nuclear Waste Policy Act Amendments Act of 1987, the process for selecting this repository was streamlined, and the Yucca Mountain site in Nevada was selected as the candidate site for a geologic repository.

Because the environmental documentation process for geologic disposal was established by the Nuclear Waste Policy Act, this EIS does not analyze environmental impacts of disposal at Yucca Mountain or alternative locations. After emplacement in a geologic repository, however, DOE expects there would be no more impacts to workers, the public, or the environment because the radioactive material would be effectively isolated.

In the event that a geologic repository were to be delayed, DOE assumed for purposes of this analysis that it would continue to manage the foreign research reactor spent nuclear fuel, or the high-level radioactive waste resulting from the chemical separation or other processing of such spent nuclear fuel, at the management sites until a geologic repository becomes available. The risk associated with this continued management is low and would not exceed the annual risk discussed in Section 4.2.4.1.

4.2.8 Summary of the Impacts of the Basic Implementation of Management Alternative 1

The principal impacts under the basic implementation of Management Alternative 1 would be occupational and public health and safety impacts. These are presented in Table 4-35 in terms of the risk of death due to cancer for each segment of the affected environment. It also shows, in the bottom rows, the highest of the individual risks and the total of the population risks. Each individual risk expresses the probability that the one individual with the maximum exposure in each situation would incur an LCF. The population risk expresses the estimated number of additional LCF among the entire exposed population.

Table 4-35 shows that the greatest radiological risks would occur during ground transport or site activities. These results are based on conservative assumptions, including: (1) every package of foreign research reactor spent nuclear fuel produces a dose rate equal to the regulatory limit, (2) truck shipments expose people at highway rest stops for times about equal to the actual driving times, and (3) one individual at the DOE site receives the maximum dose allowed by DOE regulation (5,000 mrem) every year.

Table 4-35 Maximum Estimated Radiological Health Impacts of the Basic Implementation of Management Alternative 1

| | <i>Risks (LCF)</i> | | |
|--------------------------------|---|-------------------------|----------------|
| | <i>Maximally Exposed Worker, MEI, or NPAI</i> | <i>Population</i> | |
| | | <i>General Public</i> | <i>Workers</i> |
| <i>Marine Transport</i> | | | |
| Incident-Free | 0.00052 | 0 | 0.034 |
| Accidents | 5×10^{-10} | much less than 0.000029 | --- |
| <i>Port Activities</i> | | | |
| Incident-Free | 0.00052 | 0 | 0.012 |
| Accidents | 2×10^{-10} | 0.000029 | --- |
| <i>Ground Transport</i> | | | |
| Incident-Free | 0.00052 | 0.22 | 0.071 |
| Accidents | 1.4×10^{-11} | 0.00028 | --- |
| <i>Site Activities</i> | | | |
| Incident-Free | 0.026 | 0.00027 | 0.21 |
| Accidents | 0.000010 | 0.11 | --- |
| <i>Highest Individual Risk</i> | | | |
| Incident-Free | 0.026 | ---- | --- |
| Accidents | 0.000010 | ---- | ---- |
| <i>Total Population Risk</i> | | | |
| Incident-Free | ---- | 0.22 | 0.33 |
| Accidents | ---- | 0.11 | ---- |

The highest estimated incident-free individual risk is 0.026 LCF, which would apply to an onsite radiation worker. This individual would have a 2.6 percent chance of incurring an LCF. DOE and the Department of State believe the actual risk would be much lower due to administrative procedures such as worker rotation. The highest estimated incident-free individual risk for members of the public is much lower than the maximally exposed worker risk. DOE estimates this risk to be approximately 1.4×10^{-7} LCF.

The highest estimated accident MEI risk is 0.000010 LCF, which applies to a hypothetical member of the public who lives at the site boundary. This individual's chance of incurring an LCF due to this alternative would be one in one hundred thousand. The accident risk to workers is discussed qualitatively in Section 4.2.4.1 under the heading, "Impacts of Accidents to Close-in Workers."

As shown in Table 4-35, the total incident-free population risk would be 0.22 LCF for the potentially exposed public, while the corresponding risk would be 0.33 LCF for workers. Thus, there would be an estimated 22 percent chance of incurring one additional LCF among the exposed general public, and a 33 percent chance of incurring one additional LCF among workers. The chance of incurring two additional LCFs among each population group would be even lower.

Deaths due to traffic accident trauma and LCF due to vehicle emissions are not included in Table 4-35. DOE and the Department of State estimate there could be about a 14 percent chance that a truck driver or member of the public could die in a traffic accident associated with the basic implementation of Management Alternative 1. This death would result from the traffic accident trauma and would be unrelated to the radioactive nature of the cargo.

4.3 Implementation Alternatives of Management Alternative 1

As discussed in Chapter 2, a policy of managing foreign research reactor spent nuclear fuel in the United States could be implemented by various means. These variations on the basic implementation of Management Alternative 1 of the proposed action have been grouped into seven implementation alternatives. This section discusses their policy considerations and environmental impacts. For convenience, the seven implementation alternatives are listed briefly below:

1. Acceptance of amounts of material different from the amount in the basic implementation of Management Alternative 1,
2. Acceptance of foreign research reactor spent nuclear fuel for periods of time different from the period of time in the basic implementation of Management Alternative 1,
3. Implementation through financial arrangements different from those identified in the basic implementation of Management Alternative 1,
4. Taking title to the foreign research reactor spent nuclear fuel at locations different from the location in the basic implementation of Management Alternative 1,
5. Use of wet storage technology for the interim period instead of dry storage technology as in the basic implementation of Management Alternative 1,
6. Near term conventional chemical separation of the foreign research reactor spent nuclear fuel instead of interim storage as in the basic implementation of Management Alternative 1, and
7. Development and use of a new processing technology instead of interim storage as in the basic implementation of Management Alternative 1.

4.3.1 Implementation Alternative 1: Alternative Amounts of Spent Nuclear Fuel to be Accepted

DOE and the Department of State have evaluated the policy considerations and environmental impacts for different amounts of spent nuclear fuel and target materials under this implementation alternative.

4.3.1.1 Implementation Subalternative 1a: Accept Foreign Research Reactor Spent Nuclear Fuel Only From Developing Nations

Policy Considerations

Under this implementation subalternative, up to 1.9 MTHM and about 5,000 elements of foreign research reactor spent nuclear fuel would be accepted into the United States from developing nations (defined by the World Bank as nations with other-than-high-income economies). Up to about 238 kg (525 lb) of HEU would be removed from international commerce. By excluding developed countries, which generally share our nuclear weapons nonproliferation goals, but do not necessarily share our belief in the necessity for removing HEU from use in civil programs, this subalternative would have adverse consequences for U.S. nuclear weapons nonproliferation policy.

Because the United States has been unable to accept shipments of HEU spent nuclear fuel since 1988, several foreign research reactor operators have run out of storage capacity or face safety and regulatory problems associated with the presence of spent nuclear fuel at their sites. If the United States is unable to

accept any near term shipments of spent nuclear fuel from developed countries, some reactor operators will be forced to either shut down their reactors or ship their spent nuclear fuel for reprocessing to the United Kingdom Atomic Energy Authority facility in Dounreay, United Kingdom, which is the only facility currently able and willing to reprocess foreign research reactor spent nuclear fuel. Operators in Belgium and Germany have already sent spent nuclear fuel elements to Dounreay for reprocessing. Since neither Dounreay nor any other facility is currently accepting aluminum-based research reactor spent nuclear fuel containing LEU for reprocessing, the only way a reactor operator can use reprocessing to control his spent nuclear fuel inventory is by using HEU for fuel. This could lead reactor operators to delay or cancel plans to convert to LEU, or, in some cases, to reconvert from LEU to HEU fuels.

The net result of reduced reliance on the United States is that foreign research reactor operators would be compelled to withdraw from the Reduced Enrichment for Research and Test Reactors (RERTR) program and continue operations on the HEU fuel cycle, with its lower costs and enhanced performance. Since the United States is barred from exporting HEU to virtually all foreign research reactors under the Energy Policy Act of 1992, operators would be forced to seek alternative suppliers of HEU, such as Russia and China. This could lead to renewed international commerce in weapons-usable HEU and undermine the U.S. nuclear weapons nonproliferation policy goal of seeking to minimize the civil use of HEU. Further, those countries that participated in the RERTR program considered U.S. acceptance of their spent nuclear fuel as a condition for incurring the substantial costs and technical difficulties of converting to LEU fuels. Failure to accept their spent nuclear fuel would jeopardize the nuclear weapons nonproliferation goals of the RERTR program and the reputation of the United States as a reliable partner in the conduct of international nuclear materials management.

There is another way this subalternative could undercut the RERTR program. The developing countries generally assess their technical capabilities by comparing themselves with the developed states of North America, Western Europe, and Japan. As noted above, one probable result of this subalternative is that more developed states will continue to use HEU-fueled research reactors, due to difficulty in reprocessing LEU spent nuclear fuel. If that happens, developing countries are likely to regard use of HEU-fueled reactors as more advanced and prestigious than LEU-fueled reactors, increasing the demand for such reactors as well as for HEU itself. Again, this would encourage increased stockpiles of HEU in various developed and developing countries, contrary to U.S. nuclear weapons nonproliferation policy.

If some countries are forced to shut down their reactors and thereby forego the medical and scientific benefits of these reactors, such a situation may lead to criticism that the United States is not a dependable nuclear partner. Some countries, including those in the developing world that have characterized the Treaty on the Non-Proliferation of Nuclear Weapons as a discriminatory bargain between the nuclear "haves" and the nonnuclear "have-nots," may be inclined to accuse the United States, fairly or unfairly, of having failed to comply with its Article IV Treaty pledge to facilitate "the fullest possible exchange of equipment, materials and scientific and technological information for the peaceful uses of nuclear energy." Actions that foster such negative perceptions would undoubtedly complicate the conferences which are scheduled to monitor compliance with the Non-Proliferation Treaty, and may complicate United States diplomatic efforts to attain other arms control and nuclear weapons nonproliferation objectives.

Marine Transport Impacts

Impacts of Incident-Free Marine Transport

The impacts of incident-free marine transportation were analyzed in the same manner as the basic implementation of Management Alternative 1. The incident-free transportation of spent nuclear fuel was estimated to result in total LCF that ranged from 0.008 to 0.009 over the entire duration of the program. These fatalities are the sum of the estimated number of radiation-related LCF to the ships' crews.

The range of impacts result from the analysis of shipment of the spent nuclear fuel on regularly scheduled commercial breakbulk vessels and on chartered container vessels and would be the same as for vessels analyzed in the evaluation of the basic implementation of Management Alternative 1. As in the basic implementation of Management Alternative 1, the difference between the two estimates is a result of the shorter vessel journey time for chartered vessels due to the intermediate port stops associated with the regularly scheduled commercial transport of the spent nuclear fuel.

Impacts of Accidents During Marine Transport

The consequences of the at-sea accidents for Implementation Subalternative 1a are no different than the consequences of at-sea accidents associated with the basic implementation of Management Alternative 1. For an accident involving the loss of a transportation cask in coastal waters, the maximum exposure to an individual is estimated to be 114 mrem per year. Due to the reduced number of cask shipments, the likelihood of such an accident would be reduced. Under this subalternative, 23 percent of the total number of cask shipments required under the basic implementation of Management Alternative 1 would be needed. The highest estimated risks due to an accident during marine transport would therefore be 0.00004 mrem per year peak dose to a human from the loss of a damaged cask in the deep ocean. This corresponds to an MEI risk of 1×10^{-10} LCF. This individual would have a chance of less than one in a billion of incurring an LCF due to an accident during marine transport.

Port Activity Impacts

Impacts of Incident-Free Port Activities

In the analysis of the basic implementation of Management Alternative 1, the radiological impact of port activities was estimated on a per-shipment basis. Implementation Subalternative 1a, accepting spent nuclear fuel from developing nations only, results in 23 percent of the total number of cask shipments that are required under the basic implementation of Management Alternative 1. The incident-free impacts of the port activities would be proportionally reduced. The estimated number of LCF associated with this subalternative range from 0.0008 to 0.003. As in the marine incident-free analysis, this range of impacts is the result of the analysis of two modes of spent nuclear fuel shipment, regularly scheduled commercial breakbulk vessels and chartered container vessels.

Impacts of Accidents During Port Activities

Port accident risks were calculated based on the per-shipment risks determined in the analysis of the basic implementation of Management Alternative 1. The analysis examined the impact of using a wide range of ports of entry based on the population around the port city, from high density population ports such as Elizabeth, NJ, to low-density ports such as the MOTSU terminal in North Carolina. The analysis also considered the impact of chartered shipments (no intermediate port stops before the vessel reaches the spent nuclear fuel port of entry) versus regularly scheduled commercial shipments with up to two

intermediate ports of call before the spent nuclear fuel port of entry. The port accident risks over the entire program are estimated to range from 5×10^{-8} to 0.000004 LCF from radiation. The range of fatality estimates is due to both the differences in port city populations and the number of intermediate port stops.

The consequences of the maximum foreseeable port accident are identical to those of the basic implementation of Management Alternative 1. The frequency is lower due to the reduced number of shipments, so the MEI risk is reduced to 5×10^{-11} LCF.

Ground Transport Impacts

Impacts of Incident-Free Ground Transport

Radiological impacts of incident-free ground transportation were analyzed in the same manner for Implementation Subalternative 1a as for the basic implementation of Management Alternative 1. The results are presented in Figures 4-6 through 4-9. Incident-free transportation of spent nuclear fuel was estimated to result in total latent fatalities that ranged from 0.002 to 0.06 over the entire duration of the program. These fatalities are the sum of the estimated number of radiation-related LCF to the public and the crew.

The range of fatality estimates is caused by two factors: the option of using truck or rail to transport spent nuclear fuel and combinations of Phase 1 and Phase 2 potential foreign research reactor spent nuclear fuel management sites that created varying shipment numbers and distances.

The estimated number of radiation-related LCF for transportation workers ranged from 0.001 to 0.015. The estimated number of radiation-related LCF for the general population ranged from 0.0006 to 0.045, and the estimated number of nonradiological fatalities from vehicular emissions ranged from 0.0002 to 0.01.

Impacts of Accidents During Ground Transport

The transportation accident population risks over the entire program are estimated to range from 0.0000001 to 0.00006 LCF from radiation and from 0.0001 to 0.028 traffic fatalities, depending on the transportation mode and the potential foreign research reactor spent nuclear fuel management sites that might be selected. The reason for the range of fatality estimates is the same as those described for incident-free transportation.

The maximum foreseeable offsite transportation accident is identical to that for the basic implementation of Management Alternative 1. The risk is reduced to 2.7×10^{-12} LCF due to the reduced amount of ground transport.

Management Site Impacts

Impacts of Incident-Free Management Site Activities

Impacts of incident-free site activities from Implementation Subalternative 1a are covered by the impacts from the basic implementation of Management Alternative 1. The maximally exposed worker radiation dose depends upon the duration of the receipts, not the amount of foreign research reactor spent nuclear fuel involved, and the duration in this subalternative is identical to the basic implementation of Management Alternative 1 (13 years). Thus, the maximally exposed worker dose is conservatively

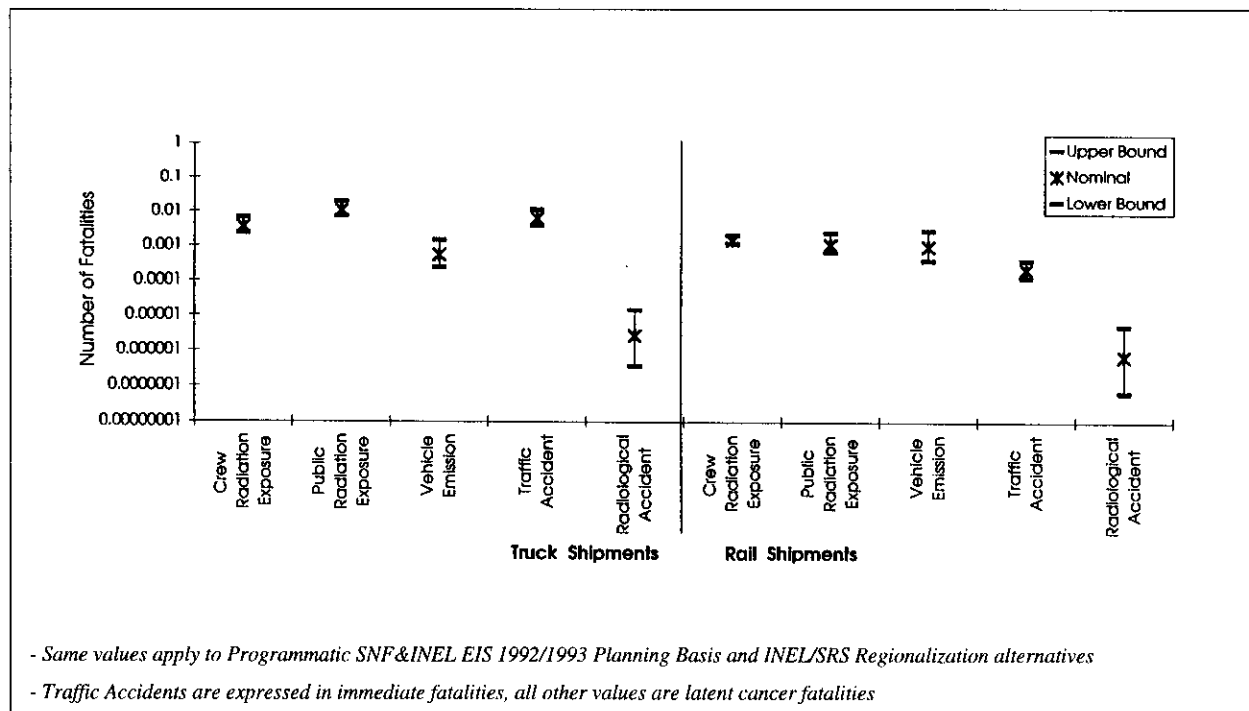


Figure 4-6 Range of Estimated Fatalities (Latent and Immediate) Under Implementation Subalternative 1a and the Programmatic SNF&INEL Final EIS Decentralization Alternative

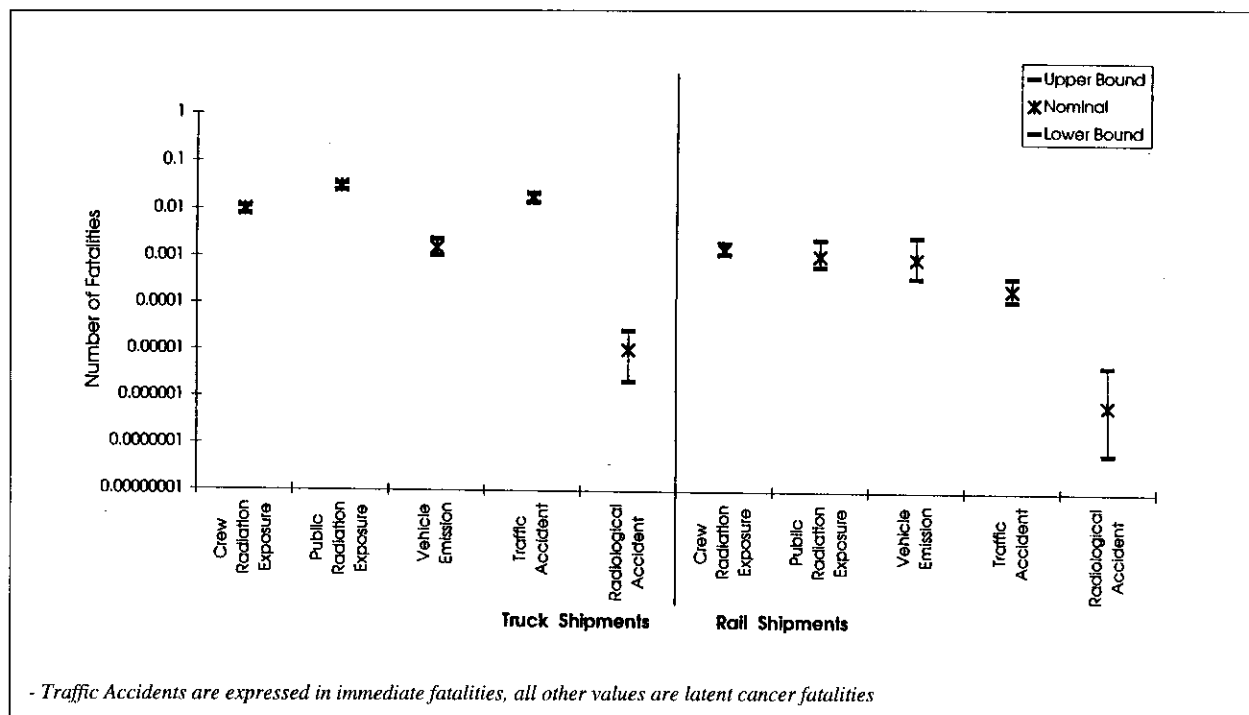


Figure 4-7 Range of Estimated Fatalities (Latent and Immediate) Under Implementation Subalternative 1a and the Programmatic SNF&INEL Final EIS Regionalization by Fuel Type Alternative

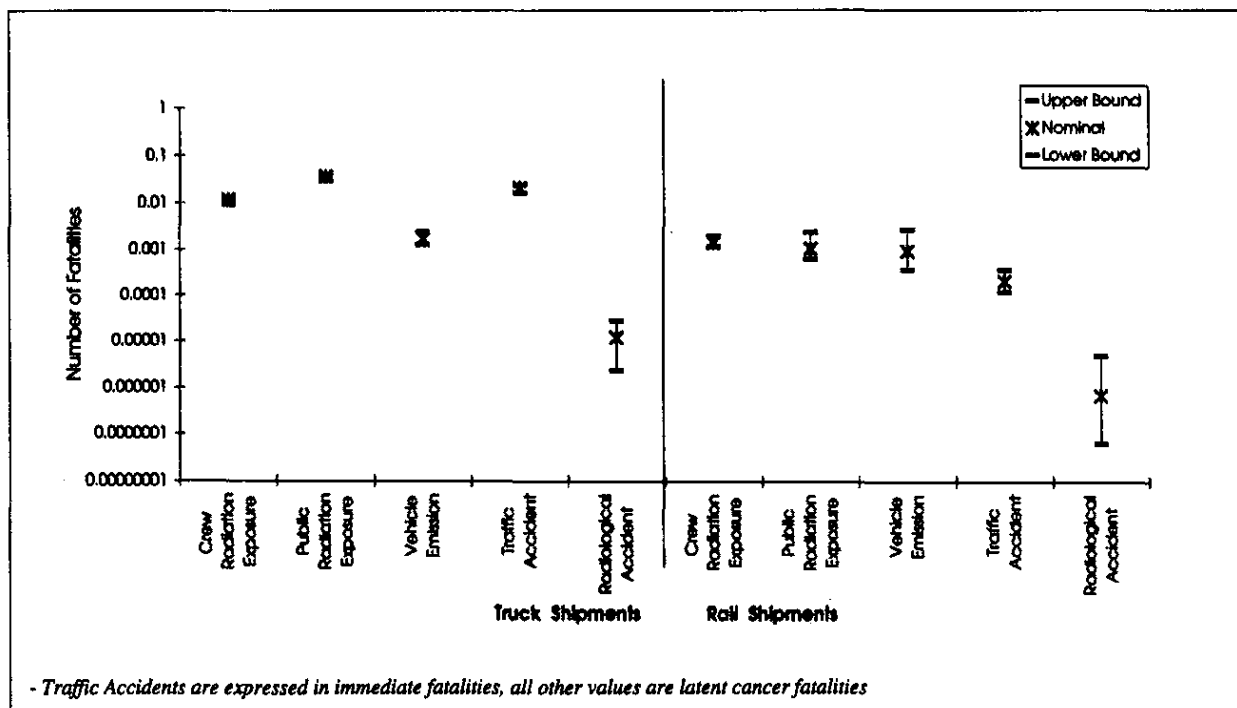


Figure 4-8 Range of Estimated Fatalities (Latent and Immediate) Under Implementation Subalternative 1a and the Programmatic SNF&INEL Final EIS Centralization to the Savannah River Site Alternative

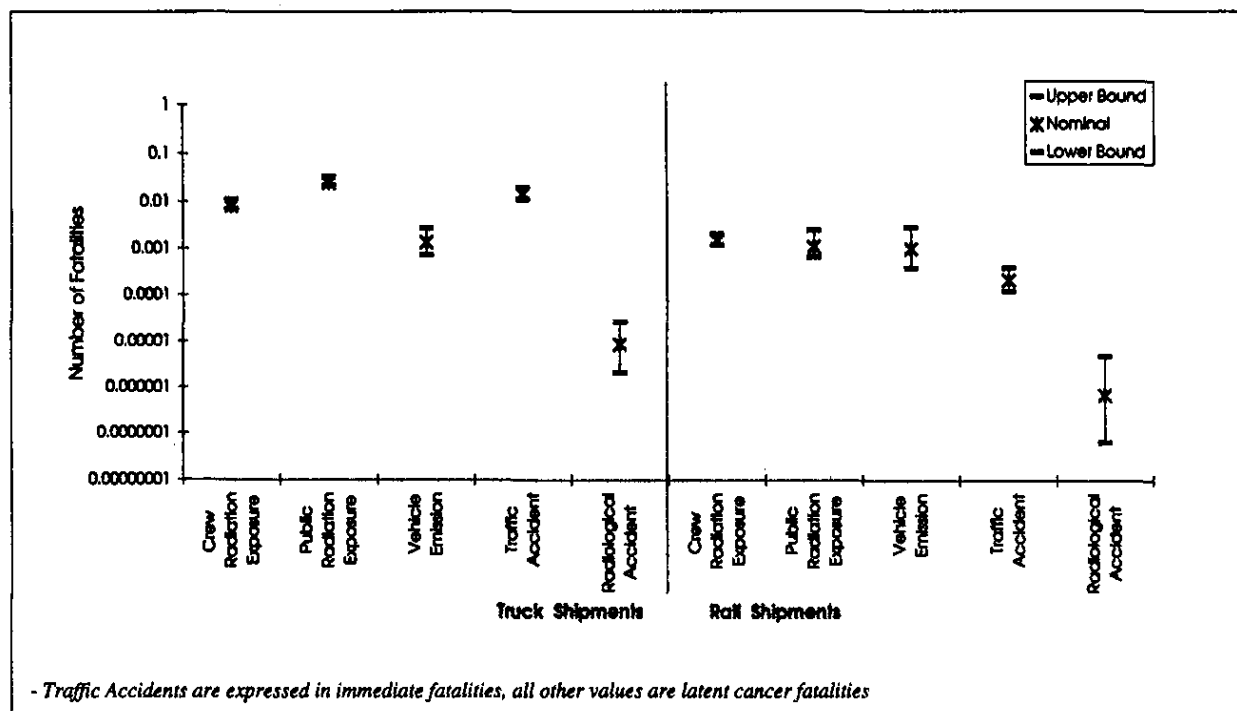


Figure 4-9 Range of Estimated Fatalities (Latent and Immediate) Under Implementation Subalternative 1a and the Programmatic SNF&INEL Final EIS Centralization to the Idaho National Engineering Laboratory Alternative

assumed to be the same as in the basic implementation of Management Alternative 1. This would produce the maximally exposed worker risk identical to that in the basic implementation of Management Alternative 1 of 0.026 LCF.

The amount of foreign research reactor spent nuclear fuel that would be received and managed is 5,000 elements or approximately 22 percent of the number of elements in the basic implementation of Management Alternative 1. Thus, it is expected that the worker population risks at each management site would be approximately 22 percent of those calculated for the basic implementation of Management Alternative 1. The highest estimate of this risk under the basic implementation of Management Alternative 1 is 0.21 LCF, so the corresponding risk for this subalternative is 0.05, LCF, which is much less than one LCF.

Similarly, some of the incident-free public risk depends on the amount of foreign research reactor spent nuclear fuel involved and some depends on the duration of each activity. The risk that accrues during receipt and handling can be scaled down by the factor of 22 percent, while the risk that accrues during storage is dependent only on the duration of the storage. The highest estimated incident-free MEI risk in the basic implementation of Management Alternative 1 (1.4×10^{-7} LCF) is due to receipt and handling, so it is reduced by a factor of 22 percent to yield the corresponding risk of 3.1×10^{-8} LCF for this subalternative.

The highest estimated incident-free public population risk in Phase 1 of the basic implementation of Management Alternative 1 (0.00014 LCF) is due to storage, so it is not reduced in this subalternative. The corresponding Phase 2 risk (0.00013 LCF) is due to receipt and handling, so this component of the risk is reduced to 0.000029 LCF for this subalternative. The sum of the Phase 1 and Phase 2 risks is 0.00017 LCF.

Impacts of Accidents Onsite

The highest estimated MEI risk due to accidents in the basic implementation of Management Alternative 1 (0.0000034 LCF) is due to an accidental criticality in RBOF. This MEI risk is greater than any of the potential Phase 2 MEI risks, when those due to receipt/handling are reduced by the factor of 22 percent. Thus, the highest MEI risk due to accidents is 0.0000034 LCF.

The highest estimated population risk due to Phase 1 accidents in the basic implementation of Management Alternative 1 (0.096 LCF) is due to an accidental criticality in RBOF. The same facility could be used for the same period of time in this subalternative, so this component of the risk is unchanged. The corresponding Phase 2 risk (0.013 LCF) is due to receipt and handling, so it is reduced by the factor of 22 percent to 0.0029 LCF for this subalternative. The sum of the Phase 1 and Phase 2 risks is 0.099 LCF.

Summary of the Impacts of Implementation Subalternative 1a

The principal impacts under this subalternative would be occupational and public health and safety impacts. These are presented in Table 4-36 in terms of the risk of death due to cancer during each of the four segments of the affected environment. It also shows, in the bottom rows, the highest of the individual risks and the total of the population risks. Each individual risk expresses the probability that one individual with the maximum exposure in each situation would incur an LCF. The population risk expresses the estimated number of additional LCF among the entire exposed population.

Table 4-36 Maximum Estimated Radiological Health Impacts of Implementation Subalternative 1a (Developing Nations Only)

| | <i>Risks (LCF)</i> | | |
|---|---|------------------------------|----------------|
| | <i>Maximally Exposed Worker, MEI, or NPAI</i> | <i>Population</i> | |
| | | <i>General Public</i> | <i>Workers</i> |
| Marine Transport Incident-Free Accidents | 0.00052 1×10^{-10} | 0 much less than 0.000004 | 0.009 --- |
| Port Activities Incident-Free Accidents | 0.00052 5×10^{-11} | 0 0.000004 | 0.003 --- |
| Ground Transport Incident-Free Accidents | 0.00052 2.7×10^{-12} | 0.045 0.00006 | 0.015 --- |
| Site Activities Incident-Free Accidents | 0.026 0.0000034 | 0.00017 0.099 | 0.05 --- |
| Highest Individual Risk Incident-Free Accidents | 0.026 0.0000034 | --- --- | --- --- |
| Total Population Risk Incident-Free Accidents | --- --- | 0.045 0.099 | 0.077 --- |

Table 4-36 shows that the greatest radiological risks would occur during ground transport or management site activities. These results are based on conservative assumptions, including: (1) every package of foreign research reactor spent nuclear fuel produces a dose rate equal to the regulatory limit, (2) truck shipments exposes people at highway rest stops for times about equal to the actual driving times, and (3) one individual at the DOE management site receives the maximum dose allowed by DOE regulation (5,000 mrem) every year.

The highest estimated incident-free individual risk is 0.026 LCF, which would apply to an onsite radiation worker. This individual would have a 2.6 percent chance of incurring an LCF. DOE and the Department of State believe the actual risk would be much lower due to administrative procedures such as worker rotation. The highest estimated incident-free individual risk for members of the public is much lower than the maximally exposed worker risk. DOE estimates this risk to be approximately 3.1×10^{-8} LCF.

The highest estimated accident MEI risk is 0.0000026 LCF, which applies to a hypothetical member of the public who lives at the site boundary. This individual's chance of incurring an LCF due to this alternative would be less than one in one hundred thousand. The accident risk to workers is discussed qualitatively in Section 4.2.4.1 under the heading, "Impacts of Accidents to Close-in Workers."

As shown in Table 4-36, the total incident-free population risk would be 0.045 LCF for the potentially exposed public, and the corresponding risk would be 0.077 LCF for workers. Thus, there would be less than a five percent chance of incurring one additional LCF among the general public, and a 7.7 percent chance of incurring one additional LCF among workers. The chance of incurring two additional LCFs among each population group would be even lower.

Deaths due to traffic accident trauma and LCF due to vehicle emissions are not included in Table 4-36. There is about a three percent chance that a truck driver or member of the public could die in a traffic accident associated with this subalternative. This death would result from the traffic accident trauma and would be unrelated to the radioactive nature of the cargo.

4.3.1.2 Implementation Subalternative 1b: Accept Only Foreign Research Reactor Spent Nuclear Fuel that Contains HEU

Policy Considerations

Under this implementation subalternative, up to about 4.6 MTHM and 11,200 elements of foreign research reactor spent nuclear fuel would be accepted into the United States. All of this foreign research reactor spent nuclear fuel would contain HEU that was enriched in the United States.

Although this implementation subalternative would remove up to about 4.6 metric tons (5.1 tons) of HEU from international commerce, it almost certainly would result in the end of the RERTR program. As discussed in Chapter 1, the foreign research reactor operators have stated that they would not participate in the RERTR program unless the United States accepts their spent nuclear fuel, including LEU spent nuclear fuel. Otherwise, many research reactor operators would be likely to insist on using HEU fuel in their reactors in the future, which would increase international commerce in HEU. The most likely suppliers of this HEU would be Russia and China. DOE and the Department of State believe that in the long run, this subalternative would be contrary to the broader U.S. policy of nuclear weapons nonproliferation. Therefore, this subalternative is not analyzed in detail for environmental impacts in this EIS.

Summary of the Impacts of Implementation Subalternative 1b

Since the number of elements in this subalternative is about half the number of elements in the basic implementation of Management Alternative 1, the impacts would be roughly half of those calculated for the basic implementation of Management Alternative 1 (see Section 4.2.8).

4.3.1.3. Implementation Subalternative 1c: Accept Target Material in Addition to Foreign Research Reactor Spent Nuclear Fuel

Policy Considerations

This implementation subalternative would entail the shipment to the United States of not only HEU and LEU spent nuclear fuel, but of residual material from the production of molybdenum-99 for medical purposes. Molybdenum-99 is produced by the irradiation of targets in a research reactor. The targets are physically similar to the fuel for foreign research reactors. After being irradiated in a reactor, the targets are dissolved in acid to recover the molybdenum, leaving residual material containing enriched uranium. The United States has supplied HEU to Canada, Belgium, Argentina, and Indonesia for use as targets in the production of medical isotopes. The NRU reactor in Canada produces nearly all radioisotopes used in nuclear medicine in the United States.

This subalternative involves the acceptance of the following amounts of target material from these countries:

| | |
|-----------|--------------------|
| Canada | 0.525 MTHM |
| Belgium | 0.029 MTHM |
| Argentina | 0.0011 MTHM |
| Indonesia | <u>0.0014 MTHM</u> |
| Total | 0.5565 MTHM |

This total has been rounded up to 0.6 MTHM for the purpose of analysis in this EIS. Under this subalternative, about 216 kg (476 lb) of HEU from target material would be removed from international commerce. This would be in addition to the estimated 4.6 metric tons (5.1 tons) of HEU that would be removed from international commerce under the basic implementation of Management Alternative 1.

Because the residual material contains weapons-usable HEU, there is a strong nuclear weapons nonproliferation rationale for including it in the scope of the management policy. This course of action would be desirable from a nuclear weapons nonproliferation standpoint, since it would leave the United States in control of the disposition of foreign research reactor spent nuclear fuel containing HEU, as well as residuals from the production of molybdenum-99, thereby minimizing the risk that such material might be diverted to a nuclear weapons program. This subalternative removes the most HEU from international civil commerce and provides the most support to U.S. nuclear weapons nonproliferation policy.

Furthermore, this subalternative would give the molybdenum-99 producers an incentive to switch from HEU targets to LEU targets. Appropriate LEU targets are currently under development as part of the RERTR program, and this target material would be accepted under this subalternative subject to the same conditions as the LEU foreign research reactor spent nuclear fuel in the basic implementation of Management Alternative 1.

The target material may be transported in one of two solid powder forms—as a calcine or an oxide. The calcine form would require about 140 cask shipments, while the oxide form would require about 57 cask shipments. The incident-free and accident risks are different for each form. The calcine material would produce an estimated 2.5 times more incident-free risk, but an estimated 10 times less accident risk than the oxide material. Furthermore, for transporting target material (unlike spent nuclear fuel), the accident risks would be greater than the incident-free risks. Therefore, to estimate conservative radiological risks, DOE and the Department of State assumed the target material would be transported as an oxide powder.

Marine Transport and Port Activities Impacts

The acceptance of target material would cause a very minor change in the marine and port incident-free impacts calculated for the basic implementation of Management Alternative 1. Up to only 7 cask shipments of oxide target material (6 from Belgium and 1¹ from Argentina or Indonesia), excluding the shipments from Canada, are estimated to be needed. This is less than one percent of the marine cask shipments of all foreign research reactor spent nuclear fuel in the basic implementation of Management Alternative 1. The incident-free impact per shipment is also reduced because the dose rate resulting from a cask loaded with the target material is expected to be much lower than that resulting from a cask loaded with foreign research reactor spent nuclear fuel.

For accident conditions, DOE and the Department of State estimated the risk due to an accident in an east coast port. The risk during marine transport would be much lower than the risk during port activities. The population risk due to accidents during port activities with seven casks of oxide target material is estimated to be 3.2×10^{-9} LCF. This is much lower than the population risk due to accidents with the foreign research reactor spent nuclear fuel.

The MEI risk is estimated to be 2.9×10^{-10} LCF, which is somewhat higher than the corresponding risk for the foreign research reactor spent nuclear fuel, but still very low.

¹ Argentina or Indonesia would not produce enough target material to fill a transportation cask. In all likelihood, the target material from these countries would be shipped along with research reactor spent nuclear fuel elements.

Ground Transport Impacts

Impacts of Incident-Free Ground Transport

The impacts of incident-free ground transportation of target material were analyzed in the same manner as for the basic implementation of Management Alternative 1, except that, based on the low activity of the target material, the maximum dose rate at a distance of 2 m (6.6 ft) from the vehicle is estimated to be 0.1 mrem per hour. The risks calculated in this section could be added to those associated with foreign research reactor spent nuclear fuel transport. The incident-free transportation of target material was estimated to result in total latent fatalities that ranged from 0.0002 to 0.003 over the entire duration of the program. These fatalities are the sum of the estimated number of radiation-related LCF to the public and the crew. When the risks of transporting target material are added to the risks of transporting the foreign research reactor spent nuclear fuel, the highest estimate of the population risk is 0.30 LCF.

The range of fatality estimates was due to two factors: the option of using truck or rail to transport target material and combinations of Phase 1 and Phase 2 sites that created varying shipment numbers and distances.

The estimated number of radiation-related LCF for transportation workers ranged from 0.00007 to 0.00074. The estimated number of radiation-related LCF for the general population ranged from 0.00015 to 0.0023, and the estimated number of nonradiological fatalities from vehicular emissions ranged from 0.0001 to 0.004.

The impacts of transportation related to target material are summarized in Figures 4-10 through 4-13 and are described in more detail in Appendix E.

Impacts of Accidents During Ground Transport

Cumulative transportation accident risks for the target material program are estimated to range from 0.0002 to 0.0054 LCF from radiation and from 0.0001 to 0.013 for traffic fatality, depending on the transportation mode and the potential foreign research reactor spent nuclear fuel management sites that might be selected. The reason for the range of fatality estimates is the same as those described for incident-free transportation. The highest estimate of the population risk due to accidents involving target material (0.0054 LCF) is higher than the same risk involving foreign research reactor spent nuclear fuel (0.00028 LCF). This difference is due to the physical/chemical forms of the two substances. Adding these two risks together yields the population risk due to accidents under Implementation Subalternative 1c, 0.0057 LCF.

The maximum foreseeable offsite transportation accident involves a cask shipment of powdered target material in a suburban population zone, and the risk is estimated to be 9.3×10^{-11} LCF to the MEI.

The impacts of transportation accidents are summarized in Figures 4-10 through 4-13, as described in the previous section, and are described in more detail in Appendix E. These tables can be used to assess the bounded absolute and relative risk of this subalternative under each representative Programmatic SNF&INEL Final EIS alternative.

Management Site Impacts

There are two methods of preparing target material for transport. The first is calcining and canning the material with the aluminum included, and the second is to remove the aluminum from the solution, then oxidize and can the residue. Canned material from the first process has similar behavior as that of

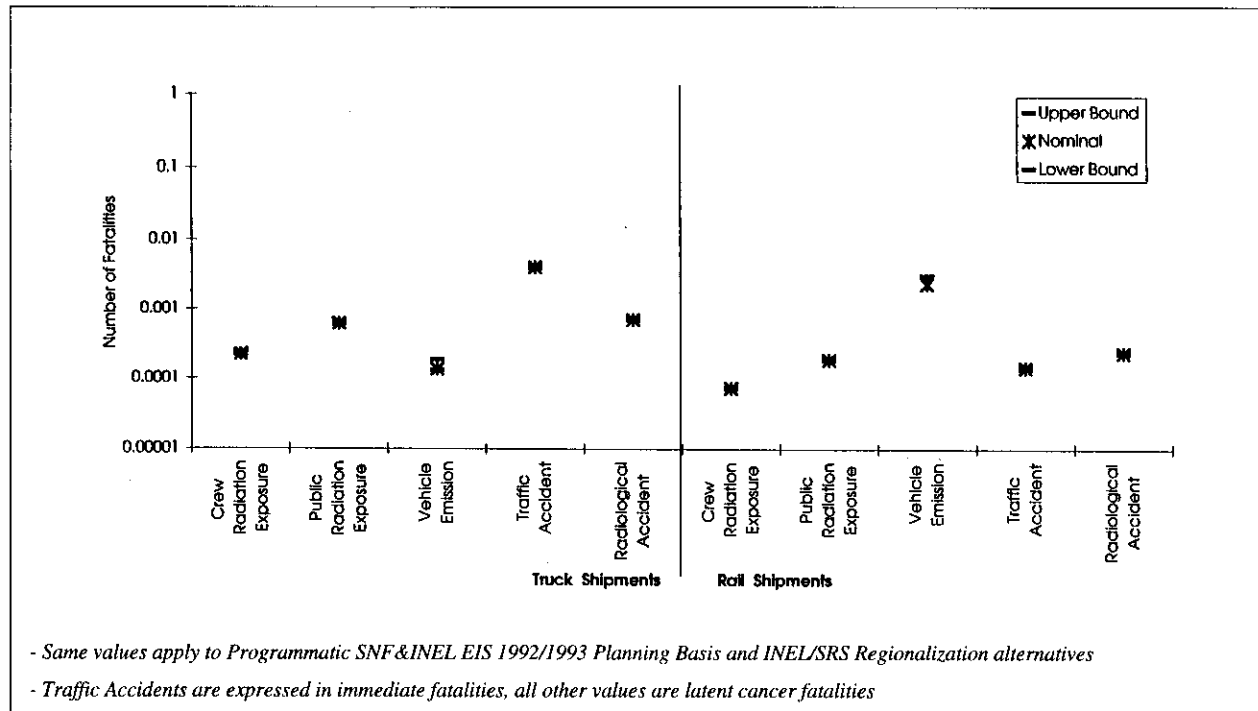


Figure 4-10 Range of Estimated Fatalities (Latent and Immediate) Under Implementation Subalternative 1c and the Programmatic SNF&INEL Final EIS Decentralization Alternative

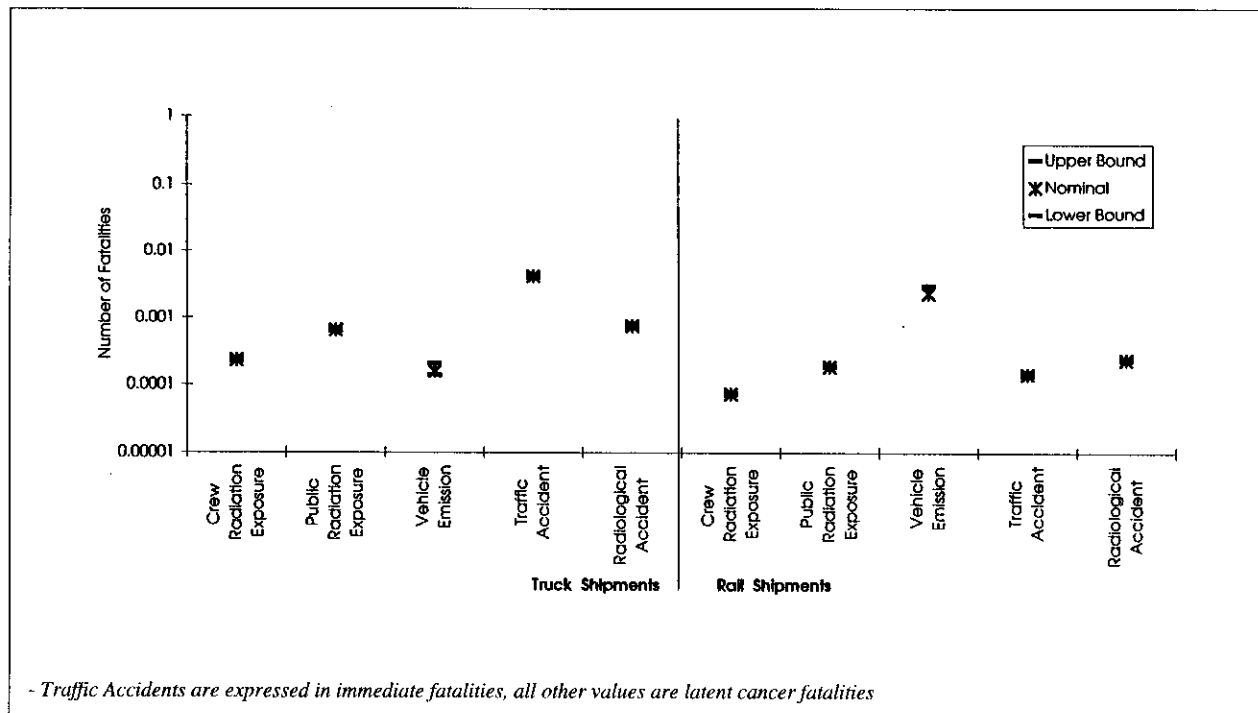


Figure 4-11 Range of Estimated Fatalities (Latent and Immediate) Under Implementation Subalternative 1c and the Programmatic SNF&INEL Final EIS Regionalization by Fuel Type Alternative

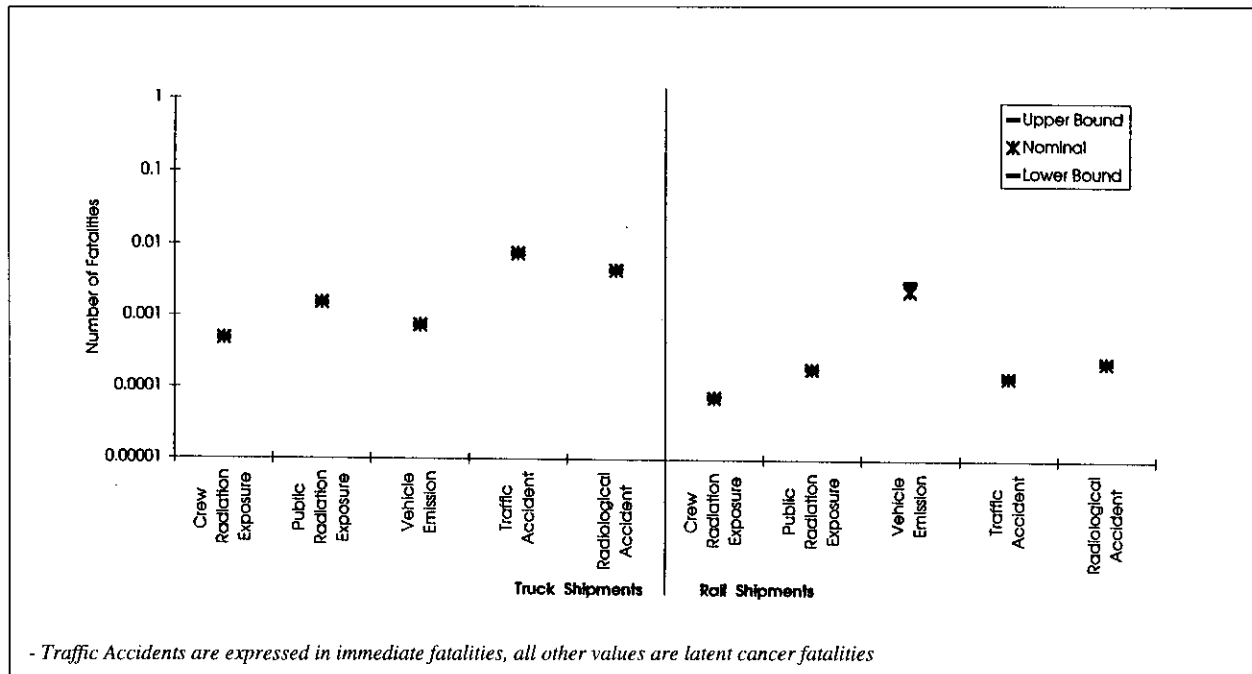


Figure 4-12 Range of Estimated Fatalities (Latent and Immediate) Under Implementation Subalternative 1c and the Programmatic SNF&INEL Final EIS Centralization to the Savannah River Site Alternative

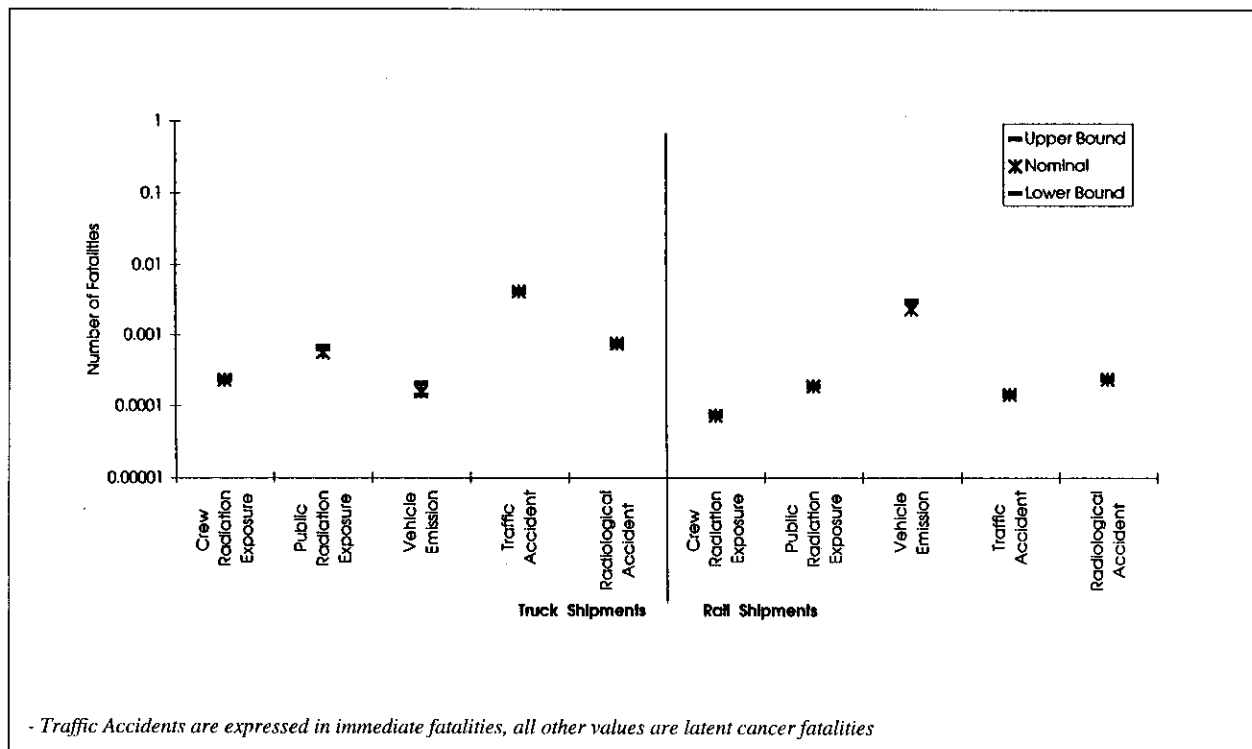


Figure 4-13 Range of Estimated Fatalities (Latent and Immediate) Under Implementation Subalternative 1c and the Programmatic SNF&INEL Final EIS Centralization to the Idaho National Engineering Laboratory Alternative

aluminum-based foreign research reactor spent nuclear fuel containing about 40 g of uranium per can. The second process allows a higher amount of uranium, about 200 g, to be packed in the same size can. Use of the first process would result in 6,750 cans representing approximately 140 cask shipments. The second process would result in 1,350 cans representing approximately 57 cask shipments.

Target material cans would be stored like foreign research reactor spent nuclear fuel elements. The storage space required is a function of volume rather than the nuclear or thermal characteristics of the target material. On average, four cans of target material could be stored in the same space as one foreign research reactor spent nuclear fuel element. Therefore, the maximum storage required for target material (in the 40-gram cans) would be equivalent to 1,700 foreign research reactor spent nuclear fuel elements or approximately 7.4 percent of the space required for the foreign research reactor spent nuclear fuel elements under the basic implementation of Management Alternative 1. The storage facilities analyzed for the basic implementation of Management Alternative 1 include this margin in the sizing.

Impacts of Incident-Free Management Site Activities

Radioactive emissions would not be expected from the target material receipt or storage because this material contains no gaseous fission products. Therefore, the incident-free radiological impacts to the public would be the same as in the basic implementation of Management Alternative 1.

The collective dose to the crews that would handle the cask shipments would be 70 person-rem, assuming that the cans from 140 cask shipments would be placed in dry storage casks. The associated worker population risk would be 0.03 LCF. Adding this risk to the worker population risk of the basic implementation of Management Alternative 1 yields 0.24 LCF for the total incident-free worker population risk for Implementation Subalternative 1c.

Impacts of Accidents Onsite

The process by which target material is prepared for shipment (i.e., drying and canning of the solutions, see Appendix B, Section B.1.5) releases all gaseous fission products. In addition, the cans do not require any trimming when they arrive at a storage facility. A review of the hypothetical accident scenarios in the basic implementation of Management Alternative 1 indicates that only the aircraft crash with fire accident scenario would be applicable to target material. The cans are never cut, and there are no gaseous fission products, so the foreign research reactor spent nuclear fuel elements breach scenario would not be applicable. In addition, should an aircraft crash into the wet storage pool where the target material is stored, or if an accidental criticality in the pool were to occur, the radioactivity releases would be bounded by those of the spent nuclear fuel analyzed for these accidents. This is because the radioactive inventory per can is very small compared to that in the bounding foreign research reactor spent nuclear fuel.

A scenario involving an aircraft crash into a dry storage facility with an ensuing fire was analyzed for the target material. The scenario assumptions are similar to those described in Appendix F, Section F.6. Because of the size of each can, it was assumed that the transfer cask involved in the accident would contain 40 cans of target material containing maximum radionuclide inventories, i.e., that of 40 cans of 200 g of uranium per can cooled for at least 3 years.

The frequency of this event is estimated to be 3 percent of the 1×10^{-6} per year used in the accident analysis of the basic implementation of Management Alternative 1. This is because the number of transfer casks involving target material is less than 3 percent of that used for the approximately 22,700 elements in the basic implementation of Management Alternative 1. Therefore, the frequency of this scenario is less

than 10^{-7} per year, and is considered to be non-foreseeable. Nonetheless, this accident was analyzed and its frequency is set conservatively at 10^{-7} per year. The analytical procedure was the same as that used in the basic implementation of Management Alternative 1.

The highest estimate of the MEI/NPAI accident risk with target material is 2.0×10^{-10} LCF, which would occur at the Oak Ridge Reservation (Table F-118, Appendix F). This risk is lower than the highest MEI/NPAI risk in the basic implementation of Management Alternative 1 (0.000010 LCF), so the risk for this subalternative is the same as in the basic implementation of Management Alternative 1. This hypothetical individual would still have one chance in one hundred thousand of incurring an LCF due to an accident on a site.

The highest estimate of the population risk with target material is 1.9×10^{-7} LCF, which also would occur at the Oak Ridge Reservation (Table F-118, Appendix F). To obtain the total population risk for this subalternative, this risk must be added to the corresponding risk from the basic implementation of Management Alternative 1 (0.11 LCF). The population risk due to accidents with target material is so small compared to the risk due to the foreign research reactor spent nuclear fuel that it makes essentially no contribution to the population risk for this subalternative. The population risk due to accidents under this subalternative would be the same as that under the basic implementation of Management Alternative 1.

Summary of the Impacts of Implementation Subalternative 1c

The principal impacts under this subalternative would be occupational and public health and safety impacts. These are presented in Table 4-37 in terms of the risk of death due to cancer during each of the four segments of this subalternative. It also shows, in the bottom rows, the highest of the individual risks and the total of the population risks. The impacts of the basic implementation of Management Alternative 1 (Table 4-35) are added to the impacts of managing the target material to obtain the impacts of this subalternative. Each individual risk expresses the probability that the one individual with the maximum exposure in each situation would incur an LCF. The population risk expresses the estimated number of additional LCF among the entire exposed population.

Table 4-37 shows that the greatest radiological risks would occur during ground transport or management site activities. These results are based on conservative assumptions, including: (1) every package of foreign research reactor spent nuclear fuel producing a dose rate equal to the regulatory limit; (2) every truck shipment exposing people at highway rest stops for times about equal to the actual driving times; and (3) one individual at the DOE site receiving the maximum dose allowed by DOE regulation ($5,000$ mrem) every year.

The highest estimated incident-free individual risk is 0.026 LCF, which would apply to an onsite radiation worker. This individual would have a 2.6 percent chance of incurring an LCF. DOE and the Department of State believe the actual risk would be much lower due to administrative procedures such as worker rotation. The highest estimated incident-free individual risk for members of the public is much lower than the maximally exposed worker risk. DOE estimates this risk to be approximately 1.4×10^{-7} LCF.

The highest estimated accident MEI risk is 0.000010 LCF, which applies to a hypothetical member of the public who lives at the site boundary. This individual's chance of incurring an LCF due to this alternative would be less than one in ten thousand. The accident risk to workers is discussed qualitatively in Section 4.2.4.1 under the heading, "Impacts of Accidents to Close-in Workers."

Table 4-37 Maximum Estimated Radiological Health Impacts of Implementation Subalternative 1c (Target Material)

| | <i>Maximum Exposed Worker, MEI, or NPAI</i> | <i>Risks (LCF)</i> | |
|--------------------------------|---|-------------------------|----------------|
| | | <i>Population</i> | |
| | | <i>General Public</i> | <i>Workers</i> |
| <i>Marine Transport</i> | | | |
| Incident-Free | 0.00052 | 0 | 0.034 |
| Accidents | 5×10^{-10} | much less than 0.000029 | --- |
| <i>Port Activities</i> | | | |
| Incident-Free | 0.00052 | 0 | 0.012 |
| Accidents | 2.9×10^{-10} | 0.000029 | --- |
| <i>Ground Transport</i> | | | |
| Incident-Free | 0.00052 | 0.22 | 0.072 |
| Accidents | 9.3×10^{-11} | 0.0057 | --- |
| <i>Site Activities</i> | | | |
| Incident-Free | 0.026 | 0.00027 | 0.24 |
| Accidents | 0.000010 | 0.11 | --- |
| <i>Highest Individual Risk</i> | | | |
| Incident-Free | 0.026 | --- | --- |
| Accidents | 0.000010 | --- | --- |
| <i>Total Population Risk</i> | | | |
| Incident-Free | --- | 0.22 | 0.36 |
| Accidents | --- | 0.12 | --- |

As shown in Table 4-37, the total incident-free population risk would be 0.22 LCF for the potentially exposed public, while the corresponding risk would be 0.36 LCF for workers. Thus, there would be an estimated 22 percent chance of incurring one additional LCF among the exposed general public, and a 36 percent chance of incurring one additional LCF among workers. The chance of incurring two additional LCFs among each population group would be even lower.

Deaths due to traffic accident trauma and LCF due to vehicle emissions are not included in Table 4-37. There is about a 15 percent chance that a truck driver or member of the public could die in a traffic accident associated with this subalternative. This death would be unrelated to the radioactive nature of the cargo.

4.3.2 Implementation Alternative 2: Alternative Policy Durations

DOE and the Department of State evaluated the impacts for two different policy durations under this implementation alternative: reducing the policy duration to 5 years and continuing the policy for HEU indefinitely.

4.3.2.1 Implementation Subalternative 2a: Five-Year Policy

Policy Considerations

Under this implementation subalternative, DOE would accept up to about 13 MTHM and about 18,800 elements of foreign research reactor spent nuclear fuel. This subalternative would reduce the number of foreign research reactor spent nuclear fuel elements that would be accepted by the United States to about 83 percent of the amount covered by the basic implementation of Management Alternative 1, and

would accelerate the time at which the foreign research reactor operators and the governments of their host countries would become responsible for disposal of their own spent nuclear fuel. Up to about 4.1 metric tons (4.5 tons) of HEU would be removed from international commerce, which is about 0.5 metric tons (0.6 tons) less than under the basic implementation of Management Alternative 1.

This subalternative probably would not provide enough time for the foreign countries, especially the developing countries, to make arrangements for alternate means of managing their spent nuclear fuel. This could pressure various foreign research reactor operators to switch their reactors back to HEU fuel. In addition, it would probably, in effect, force many of the foreign research reactors with lifetime cores to shut down prematurely because it would be very difficult for them to find any means to dispose of their foreign research reactor spent nuclear fuel, other than to have DOE accept it.

Marine Transport Impacts

Impacts of Incident-Free Marine Transport

The impacts of incident-free marine transportation in the 5-year acceptance case were analyzed in the same manner as for the basic implementation of Management Alternative 1. The analysis was performed using the dose rates based on the exclusive-use regulatory limit for the shipment of spent nuclear fuel casks. The incident-free transportation of spent nuclear fuel was estimated to result in total latent fatalities that ranged from 0.025 to 0.028 over the entire duration of the program. These fatalities are the sum of the estimated number of radiation-related LCF to the ships' crews.

The range of impacts results from the analysis of shipment of the spent nuclear fuel on regularly scheduled commercial breakbulk vessels and on chartered container vessels, and would be the same as for vessels analyzed in the basic implementation of Management Alternative 1. As in the basic implementation of Management Alternative 1, the difference between the two estimates is a result of the shorter vessel journey time for chartered vessels due to the intermediate port stops associated with the regularly scheduled commercial transport of the spent nuclear fuel.

The maximally exposed worker risk would be lower than that in the basic implementation of Management Alternative 1 due to the reduced acceptance period. The highest estimated maximally exposed worker risk would be 0.00032 LCF.

Impacts of Accidents During Marine Transport

The consequences of the at-sea accidents for Implementation Subalternative 2a are no different than the consequences of at-sea accidents associated with the basic implementation of Management Alternative 1. For an accident involving the loss of a transportation cask in coastal waters the maximum exposure to an individual is estimated to be 14,000 mrem per year. DOE and the Department of State would mitigate this impact, however, by recovering the cask. Due to the reduced number of cask shipments, the likelihood of such an accident would be reduced. Under this subalternative, approximately 81 percent of the total number of cask shipments required under the basic implementation of Management Alternative 1 would be needed. The highest risk to a human, expressed in terms of peak dose rate, would be 0.00015 mrem per year from the loss of a damaged cask in the deep ocean. Assuming an individual receives this dose for 5 years, the total MEI risk would be about 4×10^{-10} LCF.

Port Activity Impacts

Impacts of Incident-Free Port Activities

In the analysis of the basic implementation of Management Alternative 1, the radiological impact of port activities was estimated on a per-shipment basis. Implementation Subalternative 2a results in approximately 81 percent of the total number of cask shipments that are required in the basic implementation of Management Alternative 1. The incident-free impacts of the port activities would be proportionally reduced. The estimated number of LCF associated with this subalternative ranges from 0.0027 to 0.0098. As in the marine incident-free analysis, this range of impacts is the result of the analysis of two modes of spent nuclear fuel shipment, regularly scheduled commercial breakbulk vessels and chartered container vessels.

The maximally exposed worker risk would be lower than that in the basic implementation of Management Alternative 1 due to the reduced acceptance period. The estimated maximally exposed worker risk would be 0.00032 LCF.

Impacts of Accidents During Port Activities

Port accident risks were calculated based on the per-shipment risks determined in the analysis of the basic implementation of Management Alternative 1. The analysis examined the impact of using a wide range of ports based on the population around the port city, from high density population ports such as Elizabeth, NJ, to low-density ports such as the MOTSU terminal in North Carolina. The analysis also considered the impact of chartered shipments (no intermediate port stops before the vessel reaches the spent nuclear fuel port of entry) versus regularly scheduled commercial shipments with up to two intermediate ports of call before the spent nuclear fuel port of entry. The port accident risks over the entire program are estimated to range from 3×10^{-7} to 0.00002 LCF from radiation. The range of fatality estimates is due to both the differences in port city populations and the number of intermediate port stops.

The MEI risk would be lower than that of the basic implementation of Management Alternative 1 due to the reduced number of cask shipments. The highest estimated MEI risk is 1.6×10^{-10} LCF.

Ground Transport Impacts

Impacts of Incident-Free Ground Transport

The impacts of incident-free ground transportation were analyzed in the same manner as for the basic implementation of Management Alternative 1. The incident-free transportation of spent nuclear fuel was estimated to result in total latent fatalities that ranged from 0.010 to 0.27 over the entire duration of the program. These fatalities are the sum of the estimated number of radiation-related LCF to the public and the crew.

The range of fatality estimates was due to two factors: the option of using truck or rail to transport spent nuclear fuel and combinations of Phase 1 and Phase 2 management sites that created varying shipment numbers and distances.

The estimated number of radiation-related LCF for transportation workers ranged from 0.005 to 0.064. The estimated number of radiation-related LCF for the general population ranged from 0.005 to 0.20, and the estimated number of nonradiological fatalities from vehicular emissions ranged from 0.001 to 0.041.

The maximally exposed worker risk would be lower than that in the basic implementation of Management Alternative 1 due to the reduced acceptance period. The highest estimated MEI risk would be 0.00032 LCF.

The impacts of transportation are summarized in Figures 4-14 through 4-17 and are described in more detail in Appendix E.

Impacts of Accidents During Ground Transport

The cumulative transportation accident risks over the entire program are estimated to range from 0.000003 to 0.00026 LCF from radiation and from 0.001 to 0.13 for traffic fatality, depending on the transportation mode and the potential foreign research reactor spent nuclear fuel management sites that might be selected. The reason for the range of fatality estimates is the same as described for incident-free transportation.

The consequences of the maximum foreseeable offsite transportation accident are identical to those of the basic implementation of Management Alternative 1. The frequency is lower due to the reduced amount of ground transport, so the MEI risk is reduced to 1.1×10^{-11} LCF.

The impacts of transportation accidents are summarized in Figures 4-14 through 4-17, as described in the previous section, and are described in more detail in Appendix E. These tables can be used to assess the bounded absolute and relative risks of this subalternative under each representative Programmatic SNF&INEL Final EIS alternative.

Management Site Impacts

As discussed in Chapter 2 of this EIS, Implementation Subalternative 2a reduces the quantity of foreign research reactor spent nuclear fuel to be managed to approximately 18,800 elements (compared to approximately 22,700 in the basic implementation of Management Alternative 1), but increases the rate of receipt to about 2,350 elements per year for an 8-year receipt period. This rate could challenge the capability of handling the incoming foreign research reactor spent nuclear fuel at a single site and could necessitate the use of both the Idaho National Engineering Laboratory and the Savannah River Site as near term foreign research reactor spent nuclear fuel management sites.

Incident-Free Impacts

Based on the reduced number of foreign research reactor spent nuclear fuel elements that would be accepted under this subalternative, the worker population risk would be about 83 percent of that calculated for the basic implementation of Management Alternative 1. The maximally exposed worker risk was calculated in the same way as for the basic implementation of Management Alternative 1, with reduced handling time. If one worker received the maximum dose every year for eight years, his increased risk would be 0.016 LCF.

Some of the incident-free public risk depends on the amount of foreign research reactor spent nuclear fuel involved and some depends on the duration of each activity. The risk that accrues during receipt and handling can be scaled down by the factor of 83 percent from the basic implementation of Management Alternative 1, while the risk that accrues during storage is dependent only on the duration of the storage. The highest estimated incident-free public MEI risk in the basic implementation of Management Alternative 1 (1.4×10^{-7} LCF) is due to receipt and handling, so it is reduced by the factor of 83 percent to yield the corresponding risk for this subalternative (1.2×10^{-7} LCF).

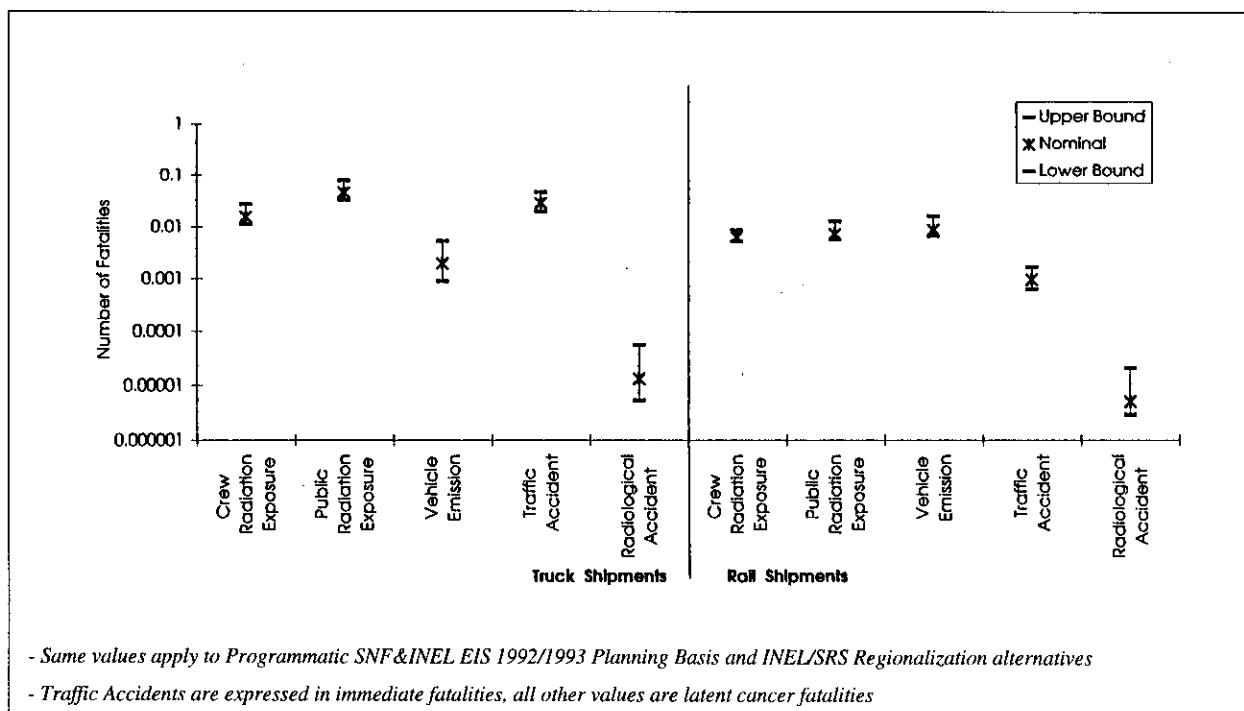


Figure 4-14 Range of Estimated Fatalities (Latent and Immediate) Under Implementation Subalternative 2a and the Programmatic SNF&INEL Final EIS Decentralization Alternative

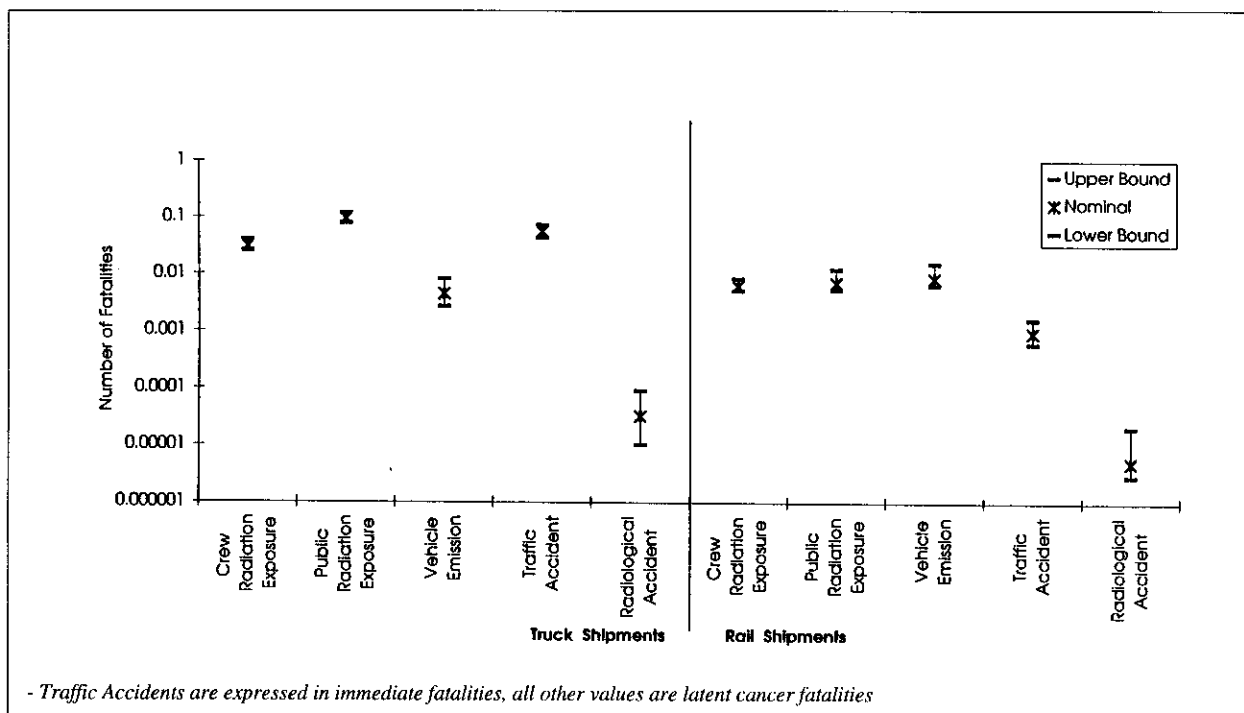


Figure 4-15 Range of Estimated Fatalities (Latent and Immediate) Under Implementation Subalternative 2a and the Programmatic SNF&INEL Final EIS Regionalization by Fuel Type Alternative

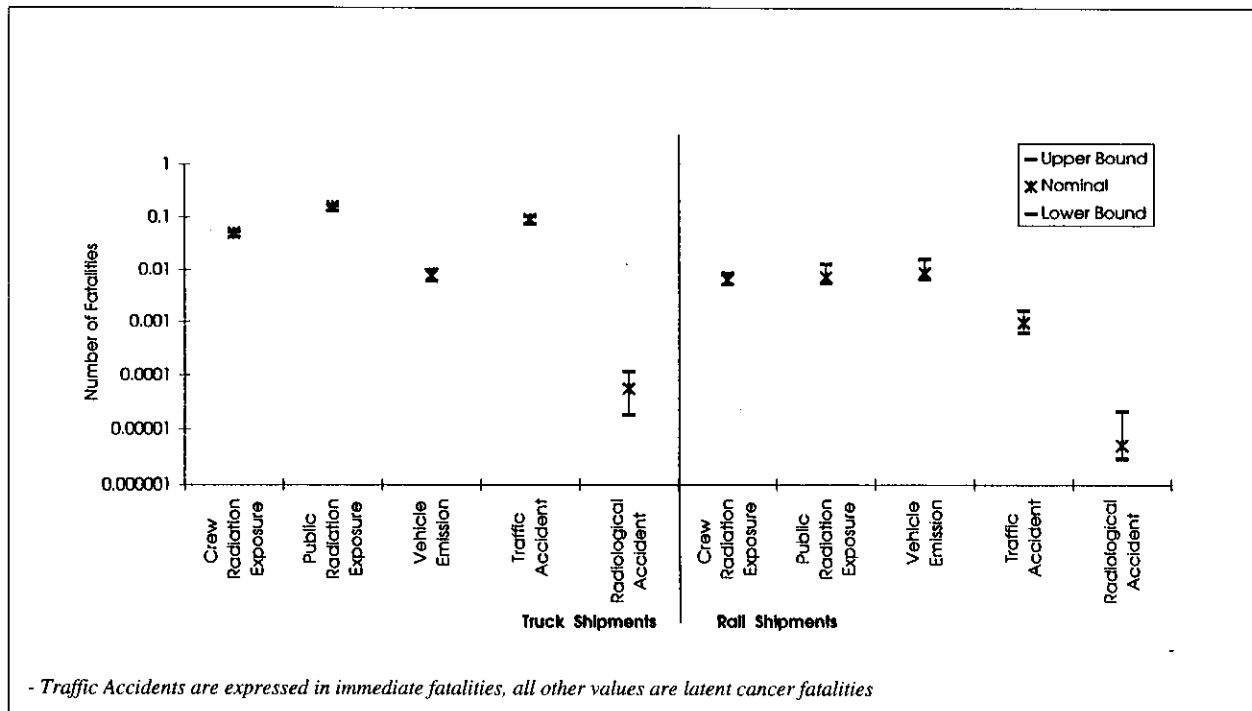


Figure 4-16 Range of Estimated Fatalities (Latent and Immediate) Under Implementation Subalternative 2a and the Programmatic SNF&INEL Final EIS Centralization to the Savannah River Site Alternative

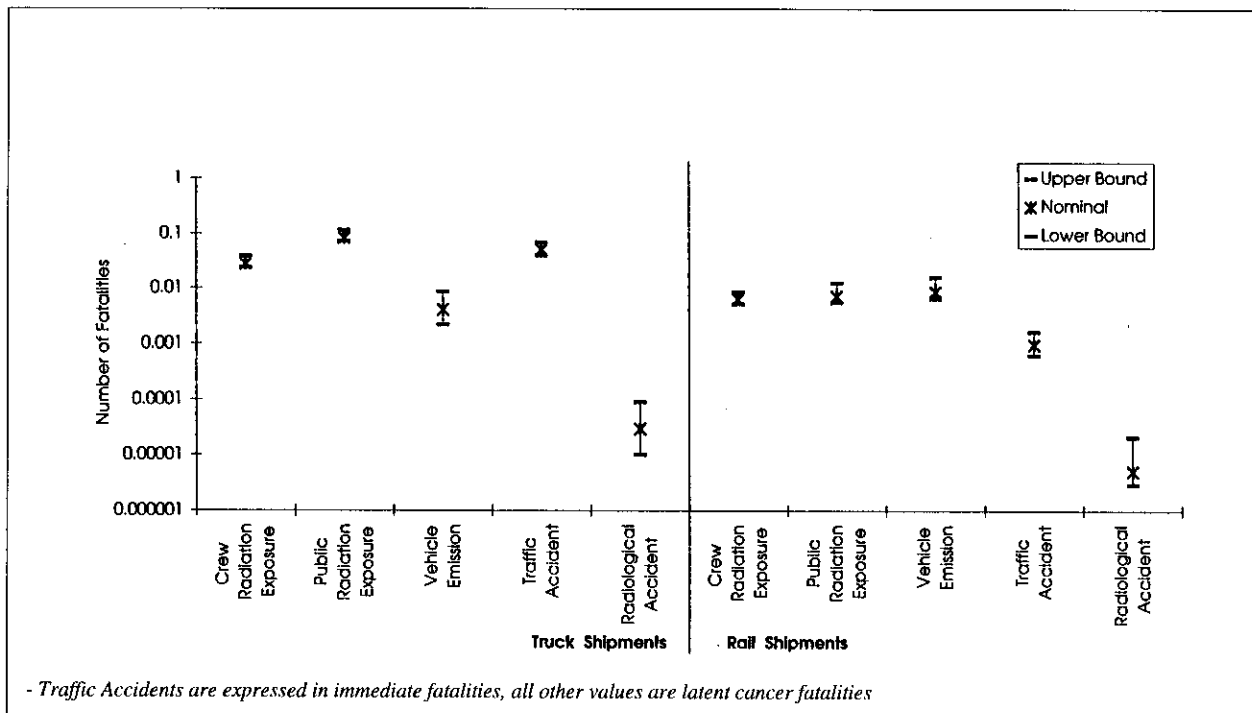


Figure 4-17 Range of Estimated Fatalities (Latent and Immediate) Under Implementation Subalternative 2a and the Programmatic SNF&INEL Final EIS Centralization to the Idaho National Engineering Laboratory Alternative

The highest estimated incident-free public population risk in Phase 1 of the basic implementation of Management Alternative 1 (0.00014 LCF) is due to 13 years of storage in L-Reactor Basin. The Phase 1 storage time in this subalternative would be slightly lower, and the estimated risk could be reduced, but for simplicity and to be conservative, DOE and the Department of State did not reduce this component of the risk estimate compared to the basic implementation. The corresponding Phase 2 risk (0.00013 LCF) is due to receipt and handling, so this component of the risk is reduced to 0.00011 LCF for this subalternative. The sum of the Phase 1 and Phase 2 risks is 0.00025 LCF.

Impacts of Accidents Onsite

The highest estimated public MEI risk due to accident conditions in the basic implementation of Management Alternative 1 (0.000010 LCF) is due to receipt and handling, so it is reduced by the factor of 83 percent to yield the corresponding risk for this subalternative (0.0000083 LCF). This is higher than any other combination of Phase 1 or Phase 2 annual risk and duration.

The highest estimated population risk due to Phase 1 accidents in the basic implementation of Management Alternative 1 (0.096 LCF) is due to an accidental criticality in RBOF. This facility would be used for less time in this subalternative and the estimated risk could be reduced, but for simplicity and to be conservative, DOE and the Department of State did not reduce this component of the risk estimate compared to the basic implementation. The corresponding Phase 2 risk (0.013 LCF) is due to receipt and handling, so this component of the risk is reduced by the factor of 83 percent, down to 0.011 LCF for this subalternative. The sum of the Phase 1 and Phase 2 risks is 0.11 LCF.

Summary of the Impacts of Implementation Subalternative 2a

The principal impacts under this subalternative would be occupational and public health and safety impacts. These are presented in Table 4-38 in terms of the risk of death due to cancer during each of the four segments of this subalternative. It also shows, in the bottom rows, the highest of the individual risks and the total of the population risks. Each individual risk expresses the probability that the one individual with the maximum exposure in each situation would incur an LCF. The population risk expresses the estimated number of additional LCF among the entire exposed population.

Table 4-38 shows that the greatest radiological risks would occur during ground transport or management site activities. These results are based on conservative assumptions, including: (1) every package of foreign research reactor spent nuclear fuel producing a dose rate equal to the regulatory limit; (2) every truck shipment exposing people at highway rest stops for times about equal to the actual driving times; and (3) one individual at the DOE site receiving the maximum dose allowed by DOE regulation (5,000 mrem) every year.

The highest estimated incident-free individual risk is 0.016 LCF, which would apply to an onsite radiation worker. This individual would have a 1.6 percent chance of incurring an LCF. DOE and the Department of State believe the actual risk would be much lower due to administrative procedures such as worker rotation. The highest estimated incident-free individual risk for members of the public is much lower than the maximally exposed worker risk. DOE estimates this risk to be approximately 1.2×10^{-7} LCF.

The highest estimated accident MEI risk is 0.0000083 LCF, which applies to a hypothetical member of the public who lives at the site boundary. This individual's chance of incurring an LCF due to this alternative would be less than one in one hundred thousand. The accident risk to workers is discussed qualitatively in Section 4.2.4.1 under the heading, "Impacts of Accidents to Close-in Workers."

Table 4-38 Maximum Estimated Radiological Health Impacts of Implementation Subalternative 2a (Five-Year Policy)

| | <i>Maximum Exposed Worker, MEI, or NPAI</i> | <i>Risks (LCF)</i> | |
|--------------------------------|---|------------------------|----------------|
| | | <i>Population</i> | |
| | | <i>General Public</i> | <i>Workers</i> |
| <i>Marine Transport</i> | | | |
| Incident-Free | 0.00032 | 0 | 0.028 |
| Accidents | 4×10^{-10} | much less than 0.00002 | --- |
| <i>Port Activities</i> | | | |
| Incident-Free | 0.00032 | 0 | 0.0098 |
| Accidents | 1.6×10^{-10} | 0.00002 | --- |
| <i>Ground Transport</i> | | | |
| Incident-Free | 0.00032 | 0.20 | 0.064 |
| Accidents | 1.1×10^{-11} | 0.00026 | --- |
| <i>Site Activities</i> | | | |
| Incident-Free | 0.016 | 0.00025 | 0.17 |
| Accidents | 0.0000083 | 0.11 | --- |
| <i>Highest Individual Risk</i> | | | |
| Incident-Free | 0.016 | --- | --- |
| Accidents | 0.0000083 | --- | --- |
| <i>Total Population Risk</i> | | | |
| Incident-Free | --- | 0.20 | 0.27 |
| Accidents | --- | 0.11 | --- |

As shown in Table 4-38, the total incident-free population risk would be 0.20 LCF for the potentially exposed public, while the corresponding risk would be 0.27 LCF for workers. Thus, there would be an estimated 20 percent chance of incurring one additional LCF among the exposed general public, and a 27 percent chance of incurring one additional LCF among workers. The chance of incurring two additional LCFs among each population group would be even lower.

Deaths due to traffic accident trauma and LCF due to vehicle emissions are not included in Table 4-38. There is about a 13 percent chance that a truck driver or member of the public could die in a traffic accident associated with this subalternative. This death would be unrelated to the radioactive nature of the cargo.

4.3.2.2 Implementation Subalternative 2b: Indefinite HEU/10-Year LEU Policy

Policy Considerations

The only difference between Implementation Subalternative 2b and the basic implementation of Management Alternative 1 would be to allow the acceptance of HEU spent nuclear fuel indefinitely from reactors with long-term lifetime cores, or from reactors whose operators for some reason (e.g., political) refuse to send their HEU spent nuclear fuel to the United States at this time. The exclusion of foreign research reactors that could be converted, but are not converted would be the same as in the basic implementation of Management Alternative 1. The amount of HEU spent nuclear fuel involved would also be the same as in the basic implementation of Management Alternative 1—only the timing would be different. The amount of HEU spent nuclear fuel that would be accepted after the policy period cannot be quantified because DOE and the Department of State do not know with certainty which countries would refuse to send their foreign research reactor spent nuclear fuel to the United States during the policy period.

of the basic implementation of Management Alternative 1. Nevertheless, this subalternative would provide a mechanism whereby DOE and the Department of State could increase the amount of U.S. origin HEU that could be recovered.

Impacts

The environmental impacts would be the same as, or slightly less than, those of the basic implementation of Management Alternative 1. Delaying the acceptance of a small fraction of the total amount of foreign research reactor spent nuclear fuel accepted would have a miniscule effect on the results presented in Section 4.2.

4.3.3 Implementation Alternative 3: Alternative Financing Arrangements

Under the basic implementation of Management Alternative 1, DOE and the Department of State would subsidize developing nations and charge developed nations a competitive rate. As discussed in Chapter 2, DOE and the Department of State have identified three potential financial arrangements:

- Subsidize all nations,
- Charge all nations the full cost of managing their spent nuclear fuel, and
- Subsidize developing nations and charge developed nations the full cost of managing their spent nuclear fuel.

Policy Considerations

Subsidizing all countries would be the most expensive for the United States. All the costs of transport, handling, storage, preparation for disposal, and disposal would be borne by the United States. The amount of HEU that would be accepted under this arrangement would likely be the same as under the basic implementation of Management Alternative 1.

Charging all countries the full cost of foreign research reactor spent nuclear fuel management would be the least expensive for the United States. All the costs would be borne by the foreign countries. Many developing countries probably would be unable to pay these high costs and this could lead to large quantities of HEU foreign research reactor spent nuclear fuel remaining in the countries least able to protect it. This could also lead to charges, rightly or wrongly, that the United States was not complying with its obligations under Article IV of the Non-Proliferation Treaty. Even some developed countries might refuse to pay a full cost recovery fee, thus broadening the scope of problems this arrangement could cause.

Subsidizing developing countries and charging developed countries full cost of spent nuclear fuel management would be somewhat less expensive for the United States than the basic implementation of Management Alternative 1. Developing countries would be treated the same as in the basic implementation of Management Alternative 1, but developed countries would be charged more than in the basic implementation of Management Alternative 1. It is not clear how much more because the amount of a full cost recovery fee cannot be determined accurately at this time. Nevertheless, this increase over the internationally competitive rate could lead those nations which can reprocess to do so and perhaps to switch back to HEU fuel. Those nations in which reprocessing is not a viable option might force their reactors to shut down, and then charge, rightly or wrongly, that the United States was not complying with its obligations under Article IV of the Non-Proliferation Treaty.

Impacts

The different financial arrangements under this implementation alternative would have no direct effect on the environmental impacts of accepting and managing foreign research reactor spent nuclear fuel. Indirect effects are possible because, if the price is too high, some reactor operators may choose not to ship their spent nuclear fuel to the United States. This would reduce the amount of spent nuclear fuel accepted and thereby reduce the environmental impacts. It would be speculative, at best, to estimate the amount of spent nuclear fuel that might be excluded under this implementation alternative compared to the basic implementation of Management Alternative 1, so the changes in the environmental impacts cannot be quantified. It is clear however, that these changes would reduce overall environmental impacts in the United States during the policy period.

4.3.4 Implementation Alternative 4: Alternative Locations for Taking Title

Policy Considerations

The Price-Anderson Act applies to the shipments, independent of who holds title to the spent nuclear fuel. Thus, there is no change in the liability protection provided to the citizens of the United States, no matter where DOE takes title to the foreign research reactor spent nuclear fuel. Hence, there would be no change in the physical mode of shipping nor in the cost of shipping. Nevertheless, DOE and the Department of State are considering the following arrangements regarding the location for taking title to the foreign research reactor spent nuclear fuel:

- Taking title prior to shipment [i.e., at the foreign research reactor(s)],
- Taking title at the port(s) of entry, and
- Taking title at the DOE management site(s).

If DOE were to take title to the foreign research reactor spent nuclear fuel at the foreign research reactors, the liability protection afforded the citizens of the United States would not change, and the shipping arrangements would still be the same. However, DOE would then be liable for any mishaps that might occur in the foreign nations, or on the high seas. Thus, the potential liability to the United States might exceed the liability under the basic implementation of Management Alternative 1.

Taking title at the port(s) of entry would leave title in the hands of the foreign research reactor operators for the distance from the U.S. territorial waters limit to the port, thus potentially causing public concern about who would be liable to respond to any accident that might occur during that portion of the shipment. Similarly, taking title at the DOE management site would leave title in the hands of the foreign research reactor operators for an even greater distance within the United States, leading to even greater public concerns. These potential concerns would be borne of a misunderstanding because ownership does not affect shipping arrangements and precautions or liability protection. Nevertheless, it is likely that such concerns would exist.

Impacts

The environmental impacts (if any) of spent nuclear fuel shipments are not affected by the identity of the owner of the spent nuclear fuel. Therefore, the point of transfer of title is not a factor in determining environmental impacts.